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HARRISON, N. J.

The Edison MAZDA Lamp for Motion Picture Projection



Information compiled by

J. A. SUMMERS

Lighting Service Department

Stereopticon Lamp

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For information regarding MAZDA lamps and lighting questions, refer to the nearest sales office as listed on the last page.

To insure receipt of bulletins, notify the Department of Publicity, Edison Lamp Works of General Electric Company, Harrison, N. J., of any change of address.

The Edison MAZDA Lamp for Motion Picture Projection

*Information compiled by J. A. Summers,
Lighting Service Department*

Advantages of Projection with MAZDA Lamps

The first conception of motion pictures is shrouded in mystery. Vague mention of pictures showing movement have been made in various writings for hundreds of years, but it was not until about 1860 when Sellers produced the effect of motion by pasting a series of consecutive photographs together that progress was started, leading to our present motion pictures.

The big advance in the science was made when Rev. Hannibal Goodwin, in 1885, invented the continuous strip photographic film, and Thomas A. Edison, between 1889 and 1894, perfected the forerunner of our present high-speed projection machine.

The carbon arc came into existence about 1800, and until recently was the only form of electric light suitable for projection work. The arc light, however, was not entirely satisfactory because of the tendency of the arc to "travel" around the crater of the carbon. This led to extensive research to develop a more constant light source.

It is a long step from the first carbonized paper filament lamp that Thomas A. Edison invented on October 21, 1879, to the present day high efficiency MAZDA lamp. With the successful application of ductile tungsten, and later operating this filament in an inert gas, the great possibilities for an incandescent projection lamp became evident.

After several years of intensive development and experimentation, projection with MAZDA lamps has now become not only practicable, but representative of the most satisfactory and efficient method. The MAZDA lamp brings into this service those features which have won its enviable position in store, factory, street lighting, etc. The projection, as to color, definition and intensity, is adequate and extremely well suited to the demands of the theater. Beyond this, the system offers a considerable economy of electrical energy, especially where alternating current is available. The saving made possible by the MAZDA lamp is indicated in Table 1.

A still further economy and convenience is that the maintenance of apparatus is very considerably reduced, there being no carbon clamps or asbestos lead wires to be replaced, while the mirror may need replacement but two or three times a year. With proper adjustment such annoying features as perceptible flicker or uneven illumination need never be encountered, since the light source is perfectly steady and not subject to "travel."

TABLE 1

ARC LAMP		MAZDA LAMP	SAVING PER YEAR (3650 HOURS) (10 HOURS DAILY) IN OPERATION OF MAZDA LAMPS AT		
Amperes of Arc	Wattage of Arc and Control Equipment	Wattage of Lamp and Control Equipment	10c. Kw-hr.	8c. Kw-hr.	6c. Kw-hr.
ARC CONTROL BY RHEOSTAT—LINE VOLTAGE 110 CONTROL OF MAZDA LAMP BY TRANSFORMER					
25	2750	990	\$605.00	\$477.00	\$349.00
30	3300	990	806.00	637.00	468.00
35	3850	990	1006.00	798.00	589.00
40	4400	990	1208.00	959.00	710.00
45	4950	990	1408.00	1120.00	830.00
50	5500	990	1608.00	1280.00	951.00
55	6050	990	1808.00	1441.00	1071.00
60	6600	990	2009.00	1602.00	1192.00
ARC CONTROL BY MOTOR-GENERATOR, COMPENSATOR, OR RECTIFIER CONTROL OF MAZDA LAMP BY TRANSFORMER					
25	1625	990	\$195.00	\$149.00	\$102.00
30	1950	990	313.00	243.00	173.00
35	2275	990	432.00	338.00	244.00
40	2600	990	551.00	433.00	315.00
45	2925	990	669.00	528.00	386.00
50	3250	990	788.00	623.00	458.00
55	3575	990	909.00	719.00	530.00
60	3900	990	1025.00	813.00	600.00

Based on a lamp cost of \$0.06 per hour and a carbon cost of \$0.05 per hour.

The light has a soft, pleasing tone, bringing out depth of the picture. The rendition of colors is also most satisfactory. The resulting, restful effect, and freedom from eyestrain, makes this type of projection popular with the audience.

The MAZDA lamp burns with equal brilliancy on alternating or direct current. Therefore, when alternating current is available, no auxiliary equipment, such as a motor generator set or synchronous converter, is required; a small hand-operated transformer that forms part of the lamp adapter serves to regulate the current requirements.

Precision in adjustment of the various elements of the optical system is required. However, when once properly aligned, a minimum of attention is necessary to secure continued, uninterrupted service. The projectionist thus finds himself free to give more attention to the manipulation of his machine and film.

As the light source is totally enclosed in the lamp bulb, the booth will be free of carbon dust and gas. This insures cleaner and more healthful working conditions, as well as longer life to the various parts of the projection machine itself, otherwise subject to the cutting action of the dust.

Often, under some modes of projection, the projectionist is subjected to excessive heat caused by the high wattage consumed. The MAZDA lamp used for projection requires a comparatively small wattage consumption. As the heat is directly proportional to the electrical energy required, it follows that there is a relatively small amount emitted, usually permitting a cool, comfortable projection room.

Field of the MAZDA Lamp for Motion Picture Projection

The new G-E incandescent lamp projector, with the 900-watt MAZDA C lamp, can be used successfully in theaters having a maximum main floor seating capacity up to 1000, for a picture not over 16 feet wide and a throw not exceeding 120 feet. It gives better results than an alternating-current arc and under average operating conditions is the equal of a direct-current arc up to 50 amperes.

For projection in churches, schools and auditoriums, the equipment with MAZDA lamps is particularly desirable, since the relatively inexperienced operator encounters so much difficulty in maintaining reasonably good adjustment in the more complicated mechanisms. Another factor which may be of even greater importance is the low power consumption, often avoiding the necessity of heavy, special wiring or of over-loading the circuit.

There will be found instances where the present motion picture lamp, when operated at 30 amperes, will not give the desired result. However, when alternating current is provided for the electrical power and the proper control apparatus used, it is perfectly feasible to bring some of these installations within the scope of the MAZDA motion picture lamp by running the lamp at a higher amperage but consequently shortening its life.

MAZDA Lamp Versus Arc Lamp

The fundamental principles of these two types of projection are the same. However, to secure the best results with the MAZDA motion picture lamp, it has been found advantageous to change several elements in the optical system.

The new parts introduced for use with this equipment, as shown in Fig. 1, are:

Special lamp house,
The MAZDA motion picture lamp,
Spherical mirror,
Prismatic condenser lens,
Special lamp socket,
Current regulator.

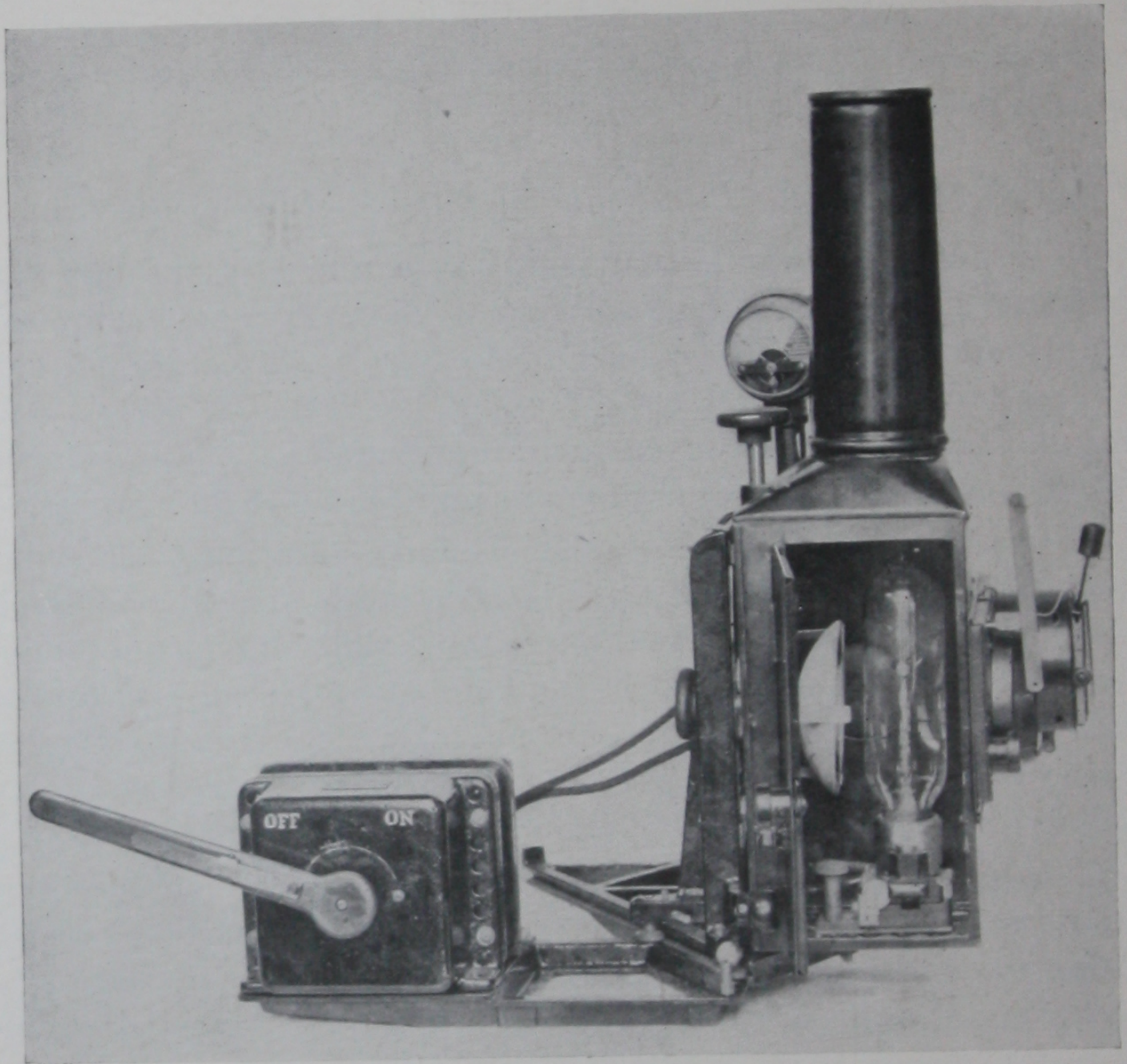


FIG. 1

G-E Model E Motion Picture Equipment for Operating 900-watt Motion Picture Lamp, Equipped with Universal Bracket Type E Regulator

The projectionist will find that the actual operation of the lamp does not entail any new complications in his work, but rather eliminates some of those with which he has been accustomed to contend. It should be recognized, nevertheless, that skill and knowledge of projection are needed to obtain good results, as the

initial adjustments of the lamp are delicate and must be thoroughly understood.

The MAZDA Motion Picture Lamp

The object of the most extensive experimental and research work has been to design a lamp and equipment that would give the

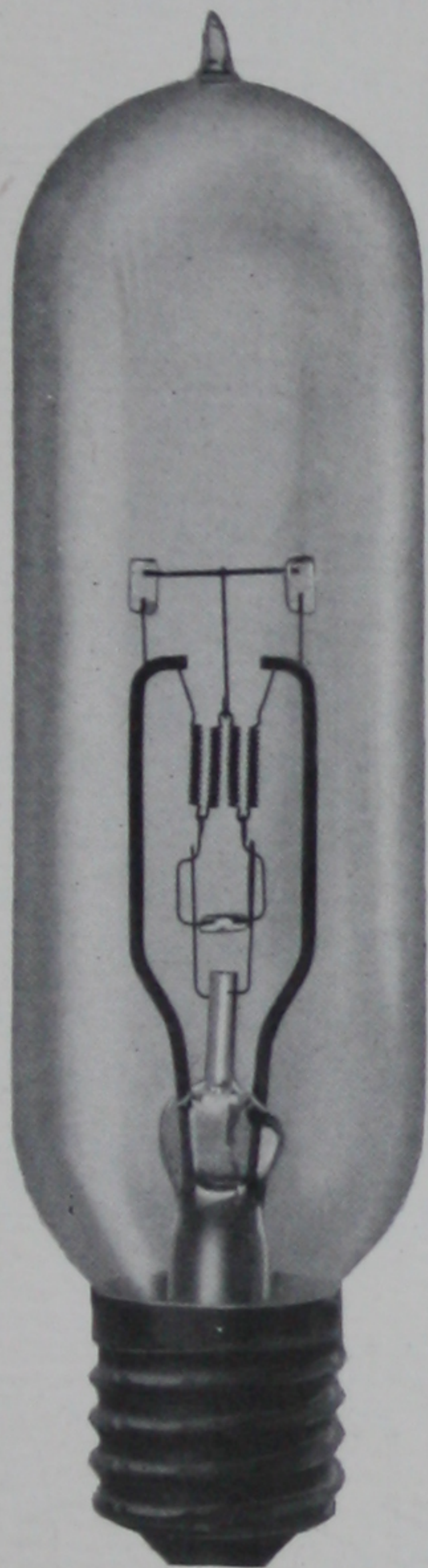


FIG. 2

900-watt, 30-ampere, 28-32-volt MAZDA C Motion Picture Lamp

best possible screen results. The 900-watt, 30-ampere, 28- to 32-volt MAZDA C (gas-filled) lamp (Fig. 2) has been found to best fulfill these requirements for theater work, and the 600-watt, 20-ampere, 28- to 32-volt MAZDA C lamp, where a smaller picture or a lower intensity of light will suffice, such as in churches, school rooms and small auditoriums.

The average burning life of these lamps is one hundred (100) hours under normal operating conditions.

The long tubular bulb permits the lamp to be located close to the condenser lens (Fig. 3) so that a large percentage of the light falls upon it. The special design of lens, developed for use with MAZDA C motion picture lamps, provides for the utilization of this

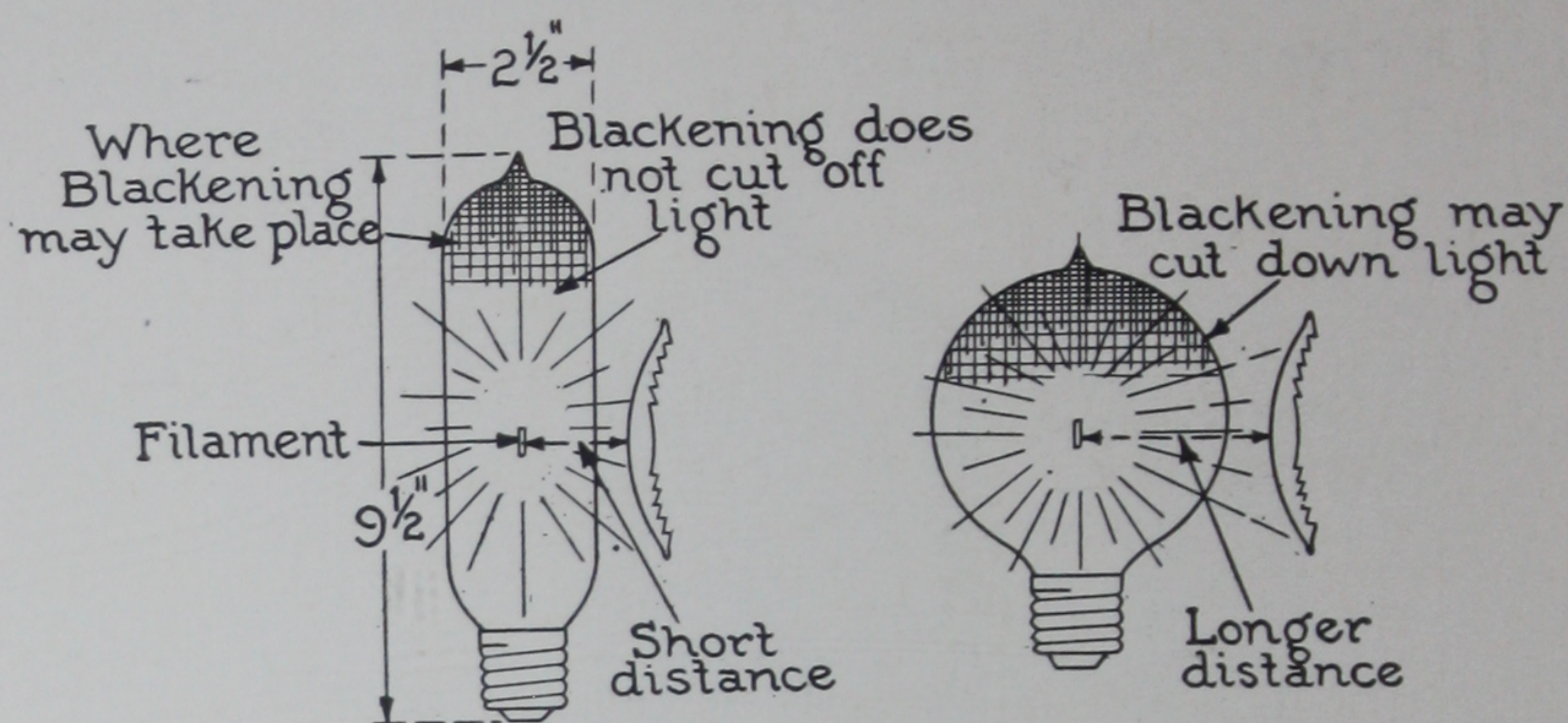


FIG. 3

Comparative Merit of Tubular vs. Round Bulb. The tubular bulb can be placed much closer to the condenser and also has its light output less affected by blackening

light so as to produce a stronger illumination on the screen. Further, this form of bulb tends to concentrate the internal blackening of the bulb where it does not absorb useful light.

The area for the light source which the prismatic condenser lens will use most efficiently is a circle, four-tenths (0.4) of an inch

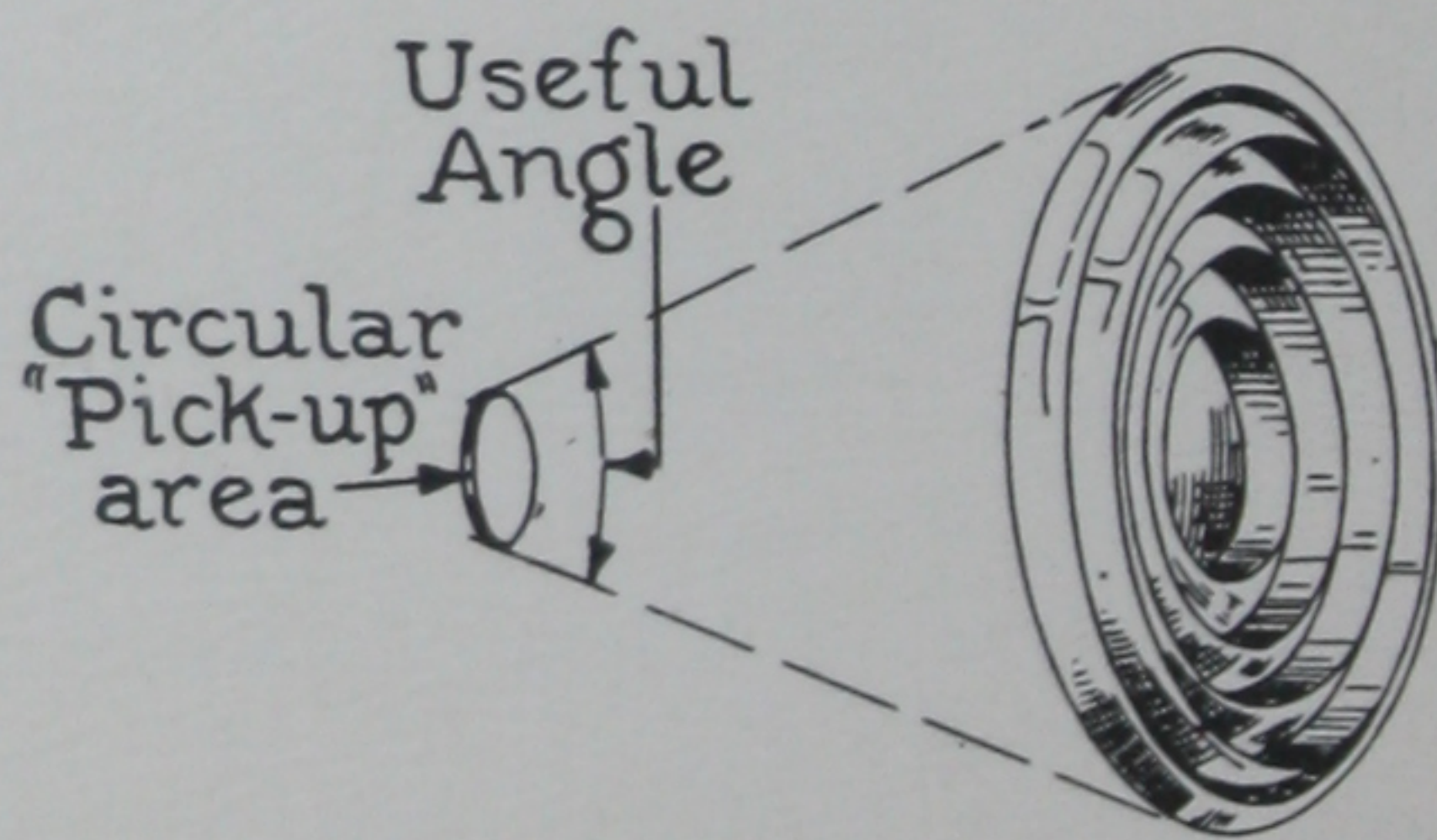


FIG. 4

"Pick-up" Area and Useful Angle of Light

in diameter (Fig. 4). Only a small proportion of the light emitted from a source not within this limit terminates as illumination on the screen, as shown in Fig. 5. The question might arise—why not enlarge this area from which the condenser

lens picks up light? That is entirely feasible, but there would be little advantage in so doing, due to the magnification by the lens, which would make too large a spot at the aperture plate and the extra light could not reach the screen.

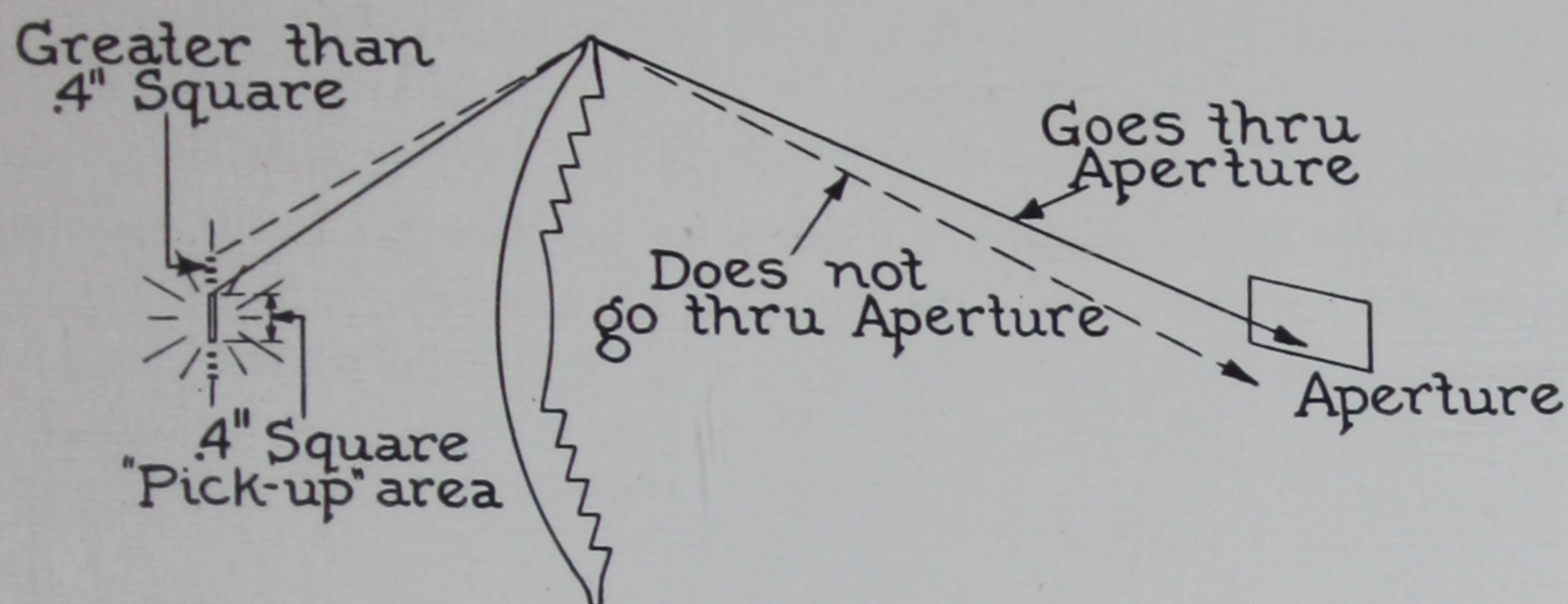


FIG. 5

Rays Outside of the "Pick-up" Area Are Shown Bent by the Condenser so That They do Not Pass Through the Aperture

Through the design adopted for the lamp filament, the largest filament surface is presented within the useful limit. As the tungsten wire used is relatively large in diameter, it allows the

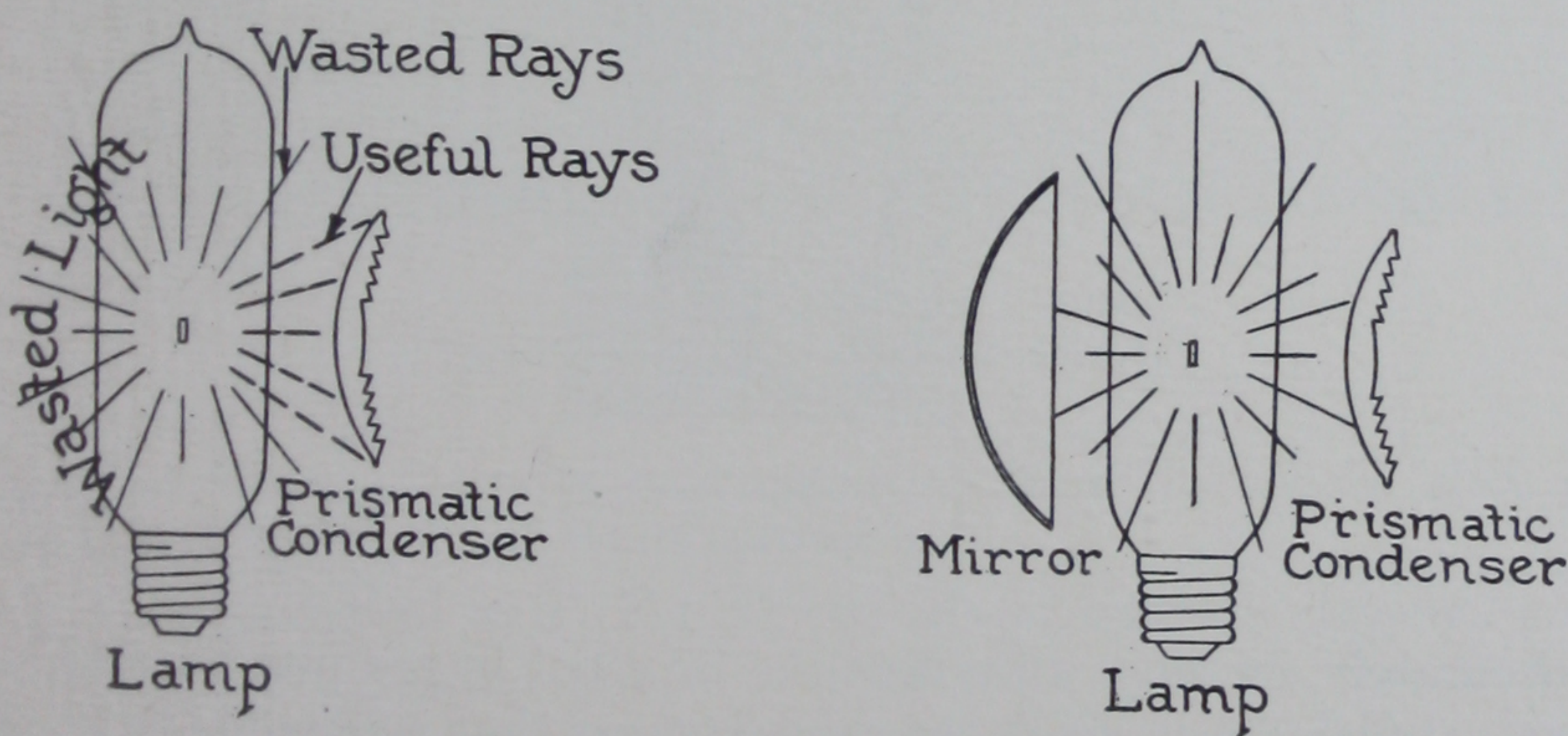


FIG. 6

Illustrating How the Mirror Utilizes a Portion of Light Which Would Otherwise be Wasted by Redirecting It Through the Light Source Toward the Condenser

lamp to operate at a temperature much higher than MAZDA lamps ordinarily burn, thus increasing the brilliancy of the light source. Since the filament is operating at this high temperature, there is a material decrease in the life of the lamp if subjected to a current in

excess of its rating, which, however, may be considered as compensated for in some instances through the additional light emitted by the lamp. The peculiar anchor construction allows for the sudden expansion and contraction of the filament when the current is turned off and on, and also tends to prevent its twisting and warping out of shape.

Spherical Mirror

The spherical mirror functions by gathering part of the light emitted from the back of the light source and redirecting it through the condenser lens as useful light (Fig. 6). The mirror should be



FIG. 7
The Spherical Mirror

accurately set so as to reflect the inverted image into that of the actual filament in much the same manner that is possible to fit the four fingers of the right hand into the four fingers of the left hand. The light thus reflected by the mirror increases the screen illumination from 50 to 70 per cent, and also tends to eliminate variations of light over the entire screen.

The mirror (Fig. 7) is a section of a sphere which focuses the light it gathers at its center of curvature. Due to the high temperatures to which this mirror is subjected, there is a gradual depreciation

of its reflecting surface; its average useful life is approximately 1000 hours operation, after which it may have to be replaced to insure good projection.

Prismatic Condenser Lens

Although the MAZDA motion picture lamp can be used with plano-convex condenser lenses, the especially designed prismatic condenser lens is recommended for this service. This possesses certain advantages, one of which is the greatly decreased likeli-

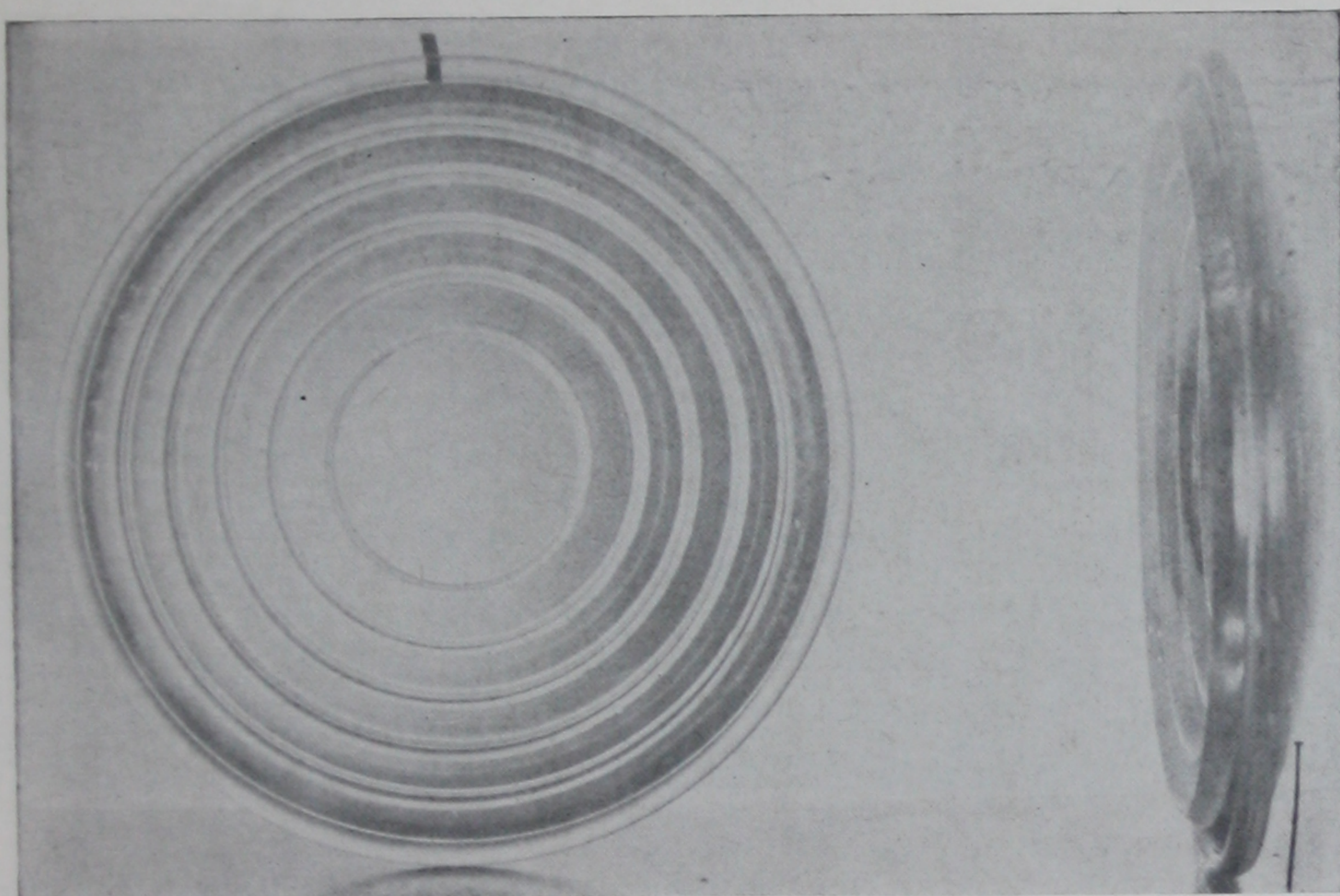


FIG. 8

Two Views of the Prismatic Condenser

hood of breakage due to heat, resulting from the special glass of which the lens is made.

This condenser unit (Fig. 8) consists of but one element, and functions as a combination of a small bull's eye lens, surrounded by five concentric prisms. The center lens simply acts as any ordinary condenser, while each prismatic section collects a band of light and bends it toward the aperture. These bands overlap and diffuse into the adjacent bands.

The MAZDA motion picture lamp does not provide a light source of absolutely uniform brilliancy, even when backed up by the image thrown by the spherical mirror. When using the ordinary condenser lenses, which focus an image of the light source

at the aperture, the filament image will be projected on the screen and have a strong tendency to cause uneven illumination. However, it is clearly seen, as outlined above, that a lens designed to diffuse the light at the aperture would give no one definite image at the aperture, thereby insuring an evenly illuminated screen. It is, therefore, worth while to emphasize the fact that, with the proper alignment, the screen illumination is uniform without dark corners or discoloration. This discoloration, obtained under certain conditions when employing plano-convex condenser lenses, is largely due to chromatic aberration.

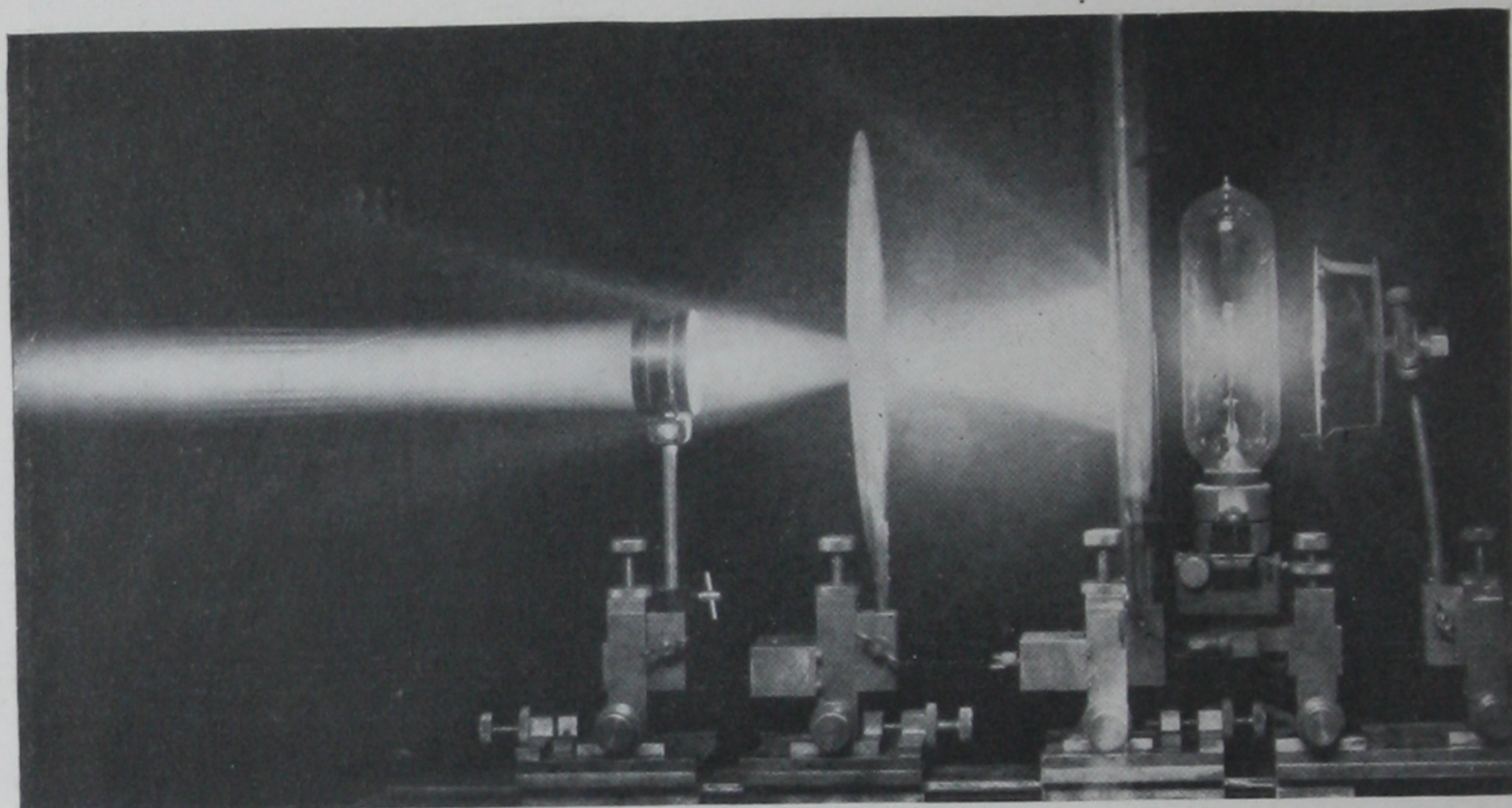


FIG. 9

Light Beam in Motion Picture Projection System Using Prismatic Condenser and No. 2 Objective Lens. It will be noted that a high percentage of the light is caught by this lens

As contrasted with the comparatively long focus of plano-convex condensers, the distance from the center of the back surface of the prismatic lens to the light source is much shorter. Naturally, the shorter we make the focus of the condenser the more light will be picked up. For illustration, if we had a stream of water issuing from a nozzle of a hose in the form of a broad spray and we attempted to catch a portion of this water in a bucket, the closer we placed the bucket to the nozzle, the more water would be collected. It is the same with light in a condenser: light issuing from a filament is analogous to the water coming from the nozzle of the hose. The condenser catches the rays of light as the bucket catches the water.

For stereopticon projection, a set of plano-convex condenser lenses must be used, and hence two sets of condensers are required—the prismatic for the motion picture and the plano for the stereopticon projection. With stereopticon projection, the projection lens is designed to pick up any image from a point directly in front of the condenser lens itself, so the lens must be smooth and perfectly clear, as is a plano-convex lens, in order to produce a uniform light on the screen. Where an attempt is made, however, to use a prismatic lens for stereopticon projection, the corrugations or rings of the condenser will be noted on the screen.

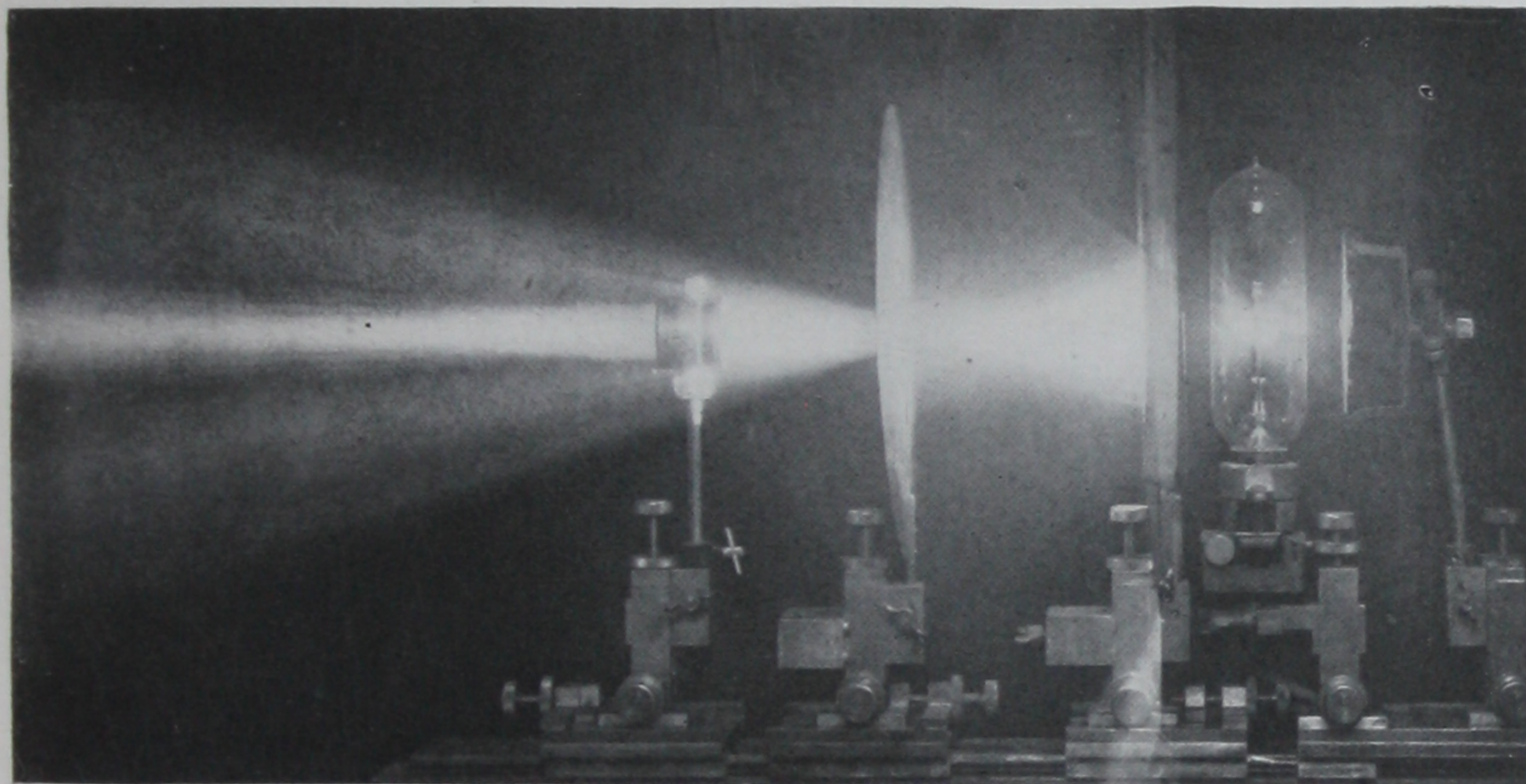


FIG. 10

Light Beam in Motion Picture Projection System Using Prismatic Condenser and No. 1 Objective Lens. It will be noted that a much smaller amount of light is caught by this lens and considerable flux wasted

Objective Lens

When projecting by using MAZDA lamps it is quite necessary to use a high grade objective lens of as large a diameter as possible, in order to utilize the maximum amount of light. By using a No. 2 lens ($2\frac{1}{2}$ in. in diameter) in place of a No. 1 lens ($1\frac{3}{4}$ in. in diameter) an increase of from 50 to 80 per cent will be obtained on the screen. This is shown quite clearly in Figs. 9 and 10.

A great deal depends on the proper selection of the projection lens. A medium size of brilliant picture is a great deal more satisfactory than a picture that is too large. Care should, therefore, be used in selecting a lens of the correct focal length to get the desired size of picture. Table 2 shows the approximate size of a picture at

a given distance from the aperture with a lens of a certain focal length.

The Lamp Setter

There are slight variations in the dimensions of individual lamps, due to the impracticability of working the glass with extreme accuracy. Since projection requires accurate work, means must be provided for the ready adjustment of the lamp, and the adjustment must be quite fine. In some housings adjustments of the lamp must be made on the housing after the lamp is inserted. Whenever possible, a lamp setter should be used.

The lamp setter is rather a unique part of the equipment which has contributed very materially to the success of projection with MAZDA lamps. By means of this device, the lamp filament may be set to the correct height, placing it directly on and at right angles to the optic axis.* Previous to the introduction of the lamp setter, one of the main difficulties encountered in obtaining satisfactory results with MAZDA lamps was the proper placement of the light source. Unless the filament is very accurately placed so that its center comes directly on the optic axis, the screen illumination will be materially reduced.

When setting the initial lamp in the apparatus, it is necessary to make adjustments of the base below the socket, causing the lamp to center on the optic axis horizontally as well as vertically. However, if all these adjustments are made with care for the initial lamp, it is simply necessary thereafter to position the filaments by means of the lamp setter and insert the lamp and socket in the housing. This greatly facilitates the operation of this equipment, as it only requires that an extra lamp be set in a spare socket ready for instant installation in case of need; the time required to change lamps should not exceed 20 seconds. It is advisable to check the mirror adjustment after a new lamp is inserted.

By studying Fig. 11, it will be seen that the lamp must be adjusted for three positions to set the filament on the optic axis. The proper height of the filament is shown in Fig. 11-A, with the bottom of the filament level with the bottom of the hole. The prongs in this opening will indicate the center of the filament laterally. Fig. 11-B shows the filament placed at right angles to the optic axis by sighting through the notches and bringing the

* The optic axis is the term used for an imaginary straight line drawn through the center of the elements of the system, i.e., with equipment for MAZDA lamps, objective lens, aperture, condenser lens, light source and mirror.

plane of the filament into the same plane with the notches. These adjustments are made by turning the screws at the top of the setter until the lamp is in the proper position. Fig. 11-C shows how to screw up the center contact. Finally, the two screws at the sides of the socket must be tightened so as to hold the lamp rigidly in position. This ball clamp has a distinct advantage over a screw socket, in that it will hold the lamp rigidly in place wherever it is placed. The large screw on the side of the socket is adjusted after

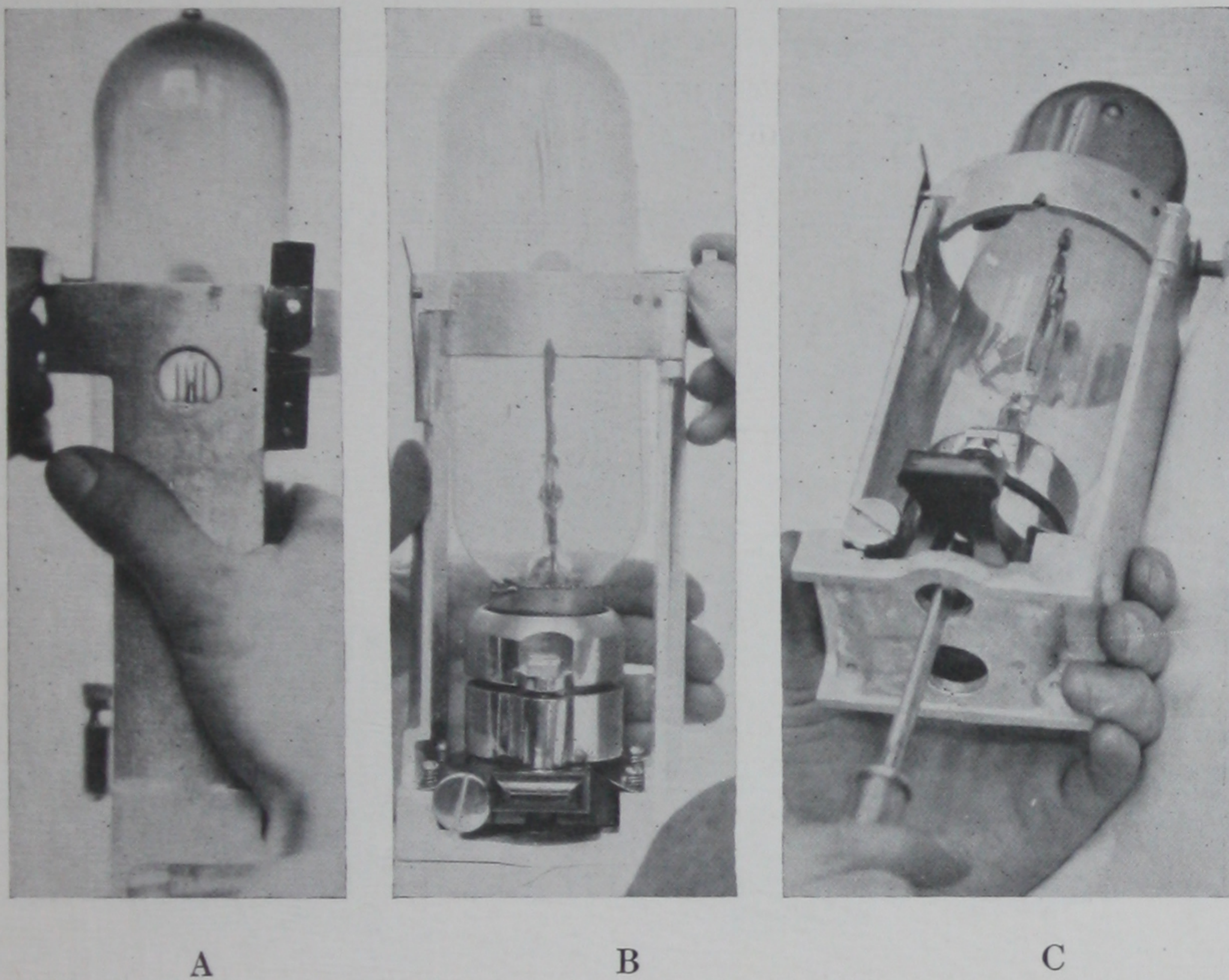


FIG. 11

The Lamp Setter Showing Methods of Making Proper Adjustments on the Lamp

the socket is put into the housing. It is by means of this screw that the filament is centered on the optic axis.

The Lamp Housing

Many designs of lamp housings have been used for projection with MAZDA lamps with varying degrees of success. The fundamental requirements of these housings are a simple method of accurately aligning the various parts of the optical system, and adequate ventilation for the lamp.

The type of equipment in Fig. 1, manufactured by the General Electric Company to meet the requirements for projection with

MAZDA lamps, gives very satisfactory results, and allows the precision adjustments to be readily made.

The complete apparatus, including the current regulator, forms a compact unit which replaces the arc housing on any of the standard makes of large American motion picture machines. A special lens holder is attached so that the prismatic condenser lens used for motion picture projection can be instantly shifted and replaced by a set of plano condenser lenses for stereopticon use. The housing itself is on a sliding base which enables it to be pushed over to one side when stereopticon projection is desired. The unusually long chimney affords the proper ventilation for the lamp. The small ammeter attached to the housing is placed where it can be easily watched.

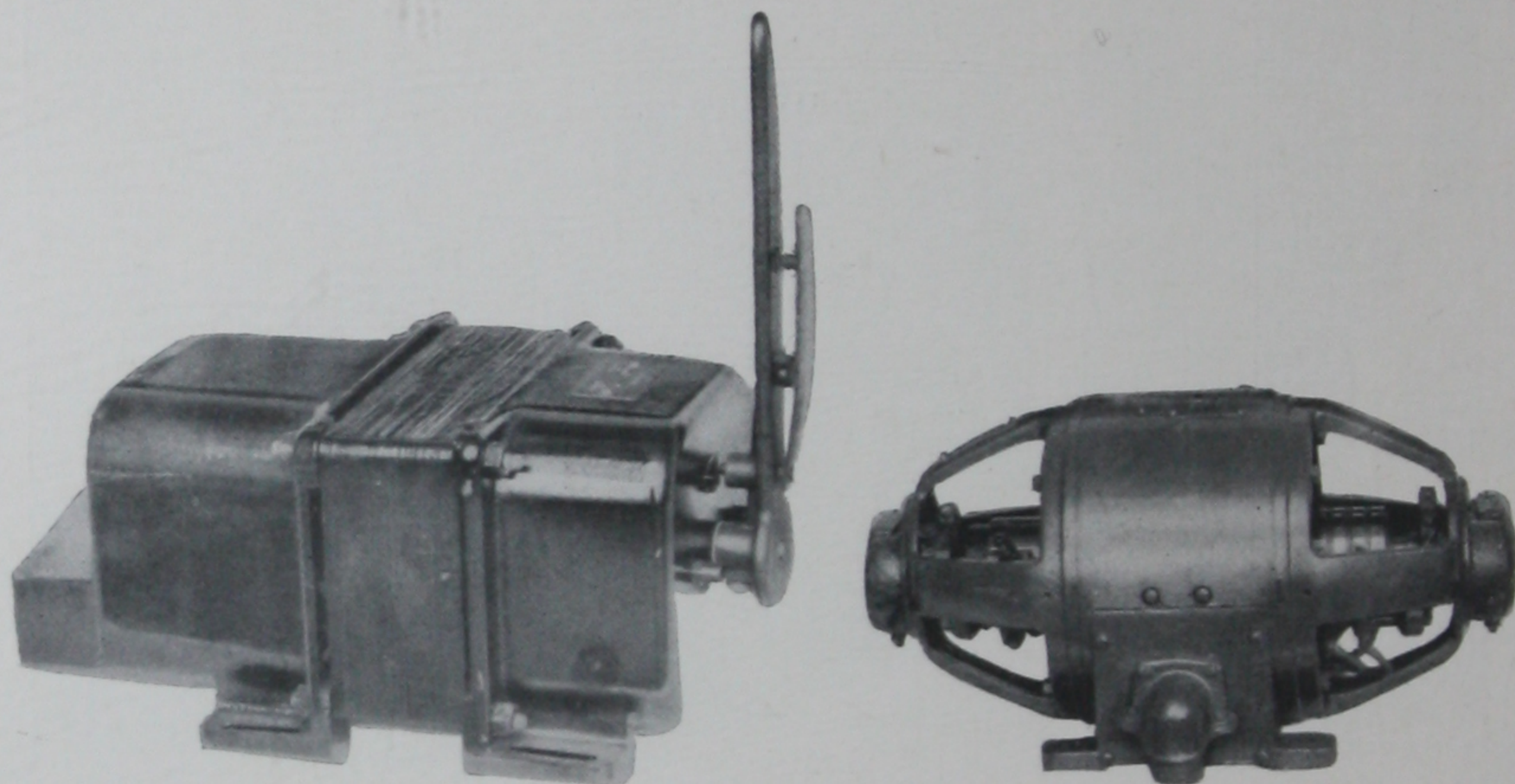


FIG. 12

Alternating-current Regulator HDS Form E Transformer Type for Operating 900-watt MAZDA Motion Picture Lamp. 100/125—200/250-volt 25/4-50-60 Cycles, and Synchronous Converter for Changing Direct Current to Alternating Current

Control Apparatus

As the lamp operates at 30 amperes and 28 to 32 volts, it is necessary to have some form of current regulating device. For use with alternating current the General Electric Company has designed a hand-controlled transformer (Fig. 12).

This apparatus permits of gradual application of voltage to the lamp, thus preventing an excessive initial surge of current through the filament which has a very harmful effect. When the filament

is cold, its resistance is very low. However, as the wire becomes hotter, the resistance increases, accompanied by expansion. When the rated voltage is supplied to the cold lamp, the heating and expansion takes place almost instantly, which is likely to cause the filament to become distorted or warped, and possibly short circuited. The combined use of the adjustable transformer and ammeter further facilitates the accurate control of the amperes in the lamp.

It has been the practice in many cases on direct current to use an adjustable resistance for control. However, this method of regulation is very uneconomical, due to the high wattage consumed by the resistance. A small synchronous converter (Fig. 12) which also has a special hand-operated transformer as an auxiliary, gives far better service, as it is more efficient than the use of resistance.

When employing MAZDA lamps for projection in connection with country home lighting outfits, it is good practice to use an adjustable resistance in series with the line to compensate for the fluctuations in the voltage when starting the lamp. Unless such resistance is used, there may be a sudden surge of current (amperes) which, as previously explained, is liable to burn out the lamp filament.

Proper Alignment of Optical System

It is of the utmost importance, when using MAZDA lamps for projection, that accurate alignment of the optical system be obtained. In other words, the mirror, lamp filament, aperture and objective lens must be so placed that their centers lie on the same straight line, known as the optic axis.

To insure the most efficient results, it is recommended that the following method be employed. It will be found an aid, in following this explanation, to refer to diagram, Fig. 13. Six steps are necessary when setting the first lamp:

1. Set lamp in lamp setter.
2. Measure distance aperture to condenser.
3. Measure distance lamp to condenser.
4. Center condenser rings through aperture and objective.
5. Center filament image through condenser.
6. Adjust mirror through dowser pinhole for size and position of image.

After adjustments have been made, it is only necessary to adjust lamp and mirror when a new lamp is inserted. However, it

is advisable to check all the conditions frequently to be sure that none of the adjustments have been disturbed.

First move the lamp house into position, placing the condenser at the correct distance from the aperture plate ($6\frac{1}{2}$ in.). By the aid of the exterior lamp setter, the lamp should be aligned as explained under that heading, and inserted in the housing. The lamp filament should normally be $2\frac{1}{2}$ in. from the rim of the lens as shown in Fig. 13, but variations in the manufacture of lenses may make it necessary to draw the lamp $\frac{1}{8}$ in. to $\frac{1}{4}$ in. further away from the condenser to get the maximum light on the screen. Light the lamp at the lowest current permitted by the control apparatus, thus avoiding excessive brightness and undue eyestrain during the adjustments.

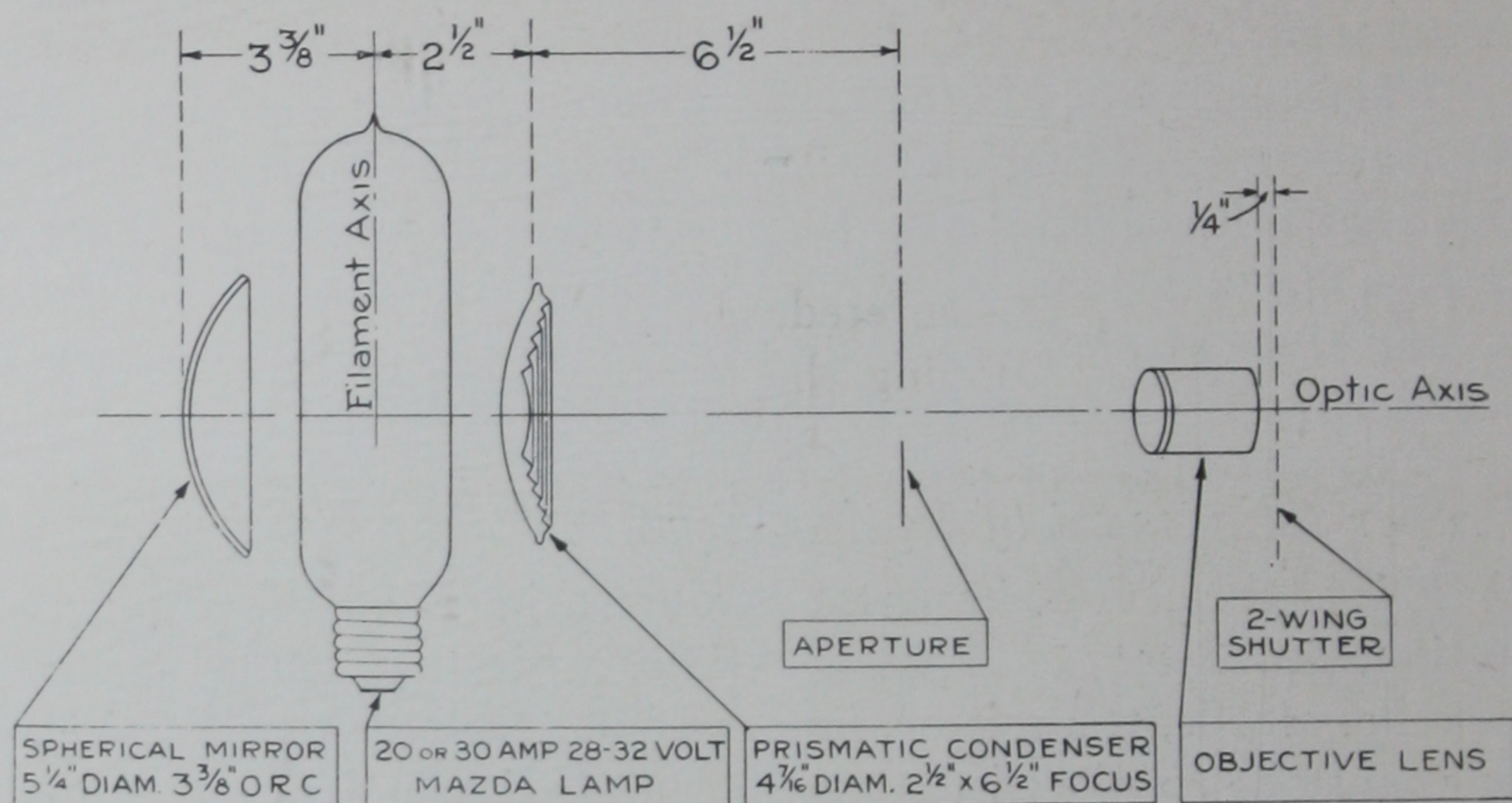
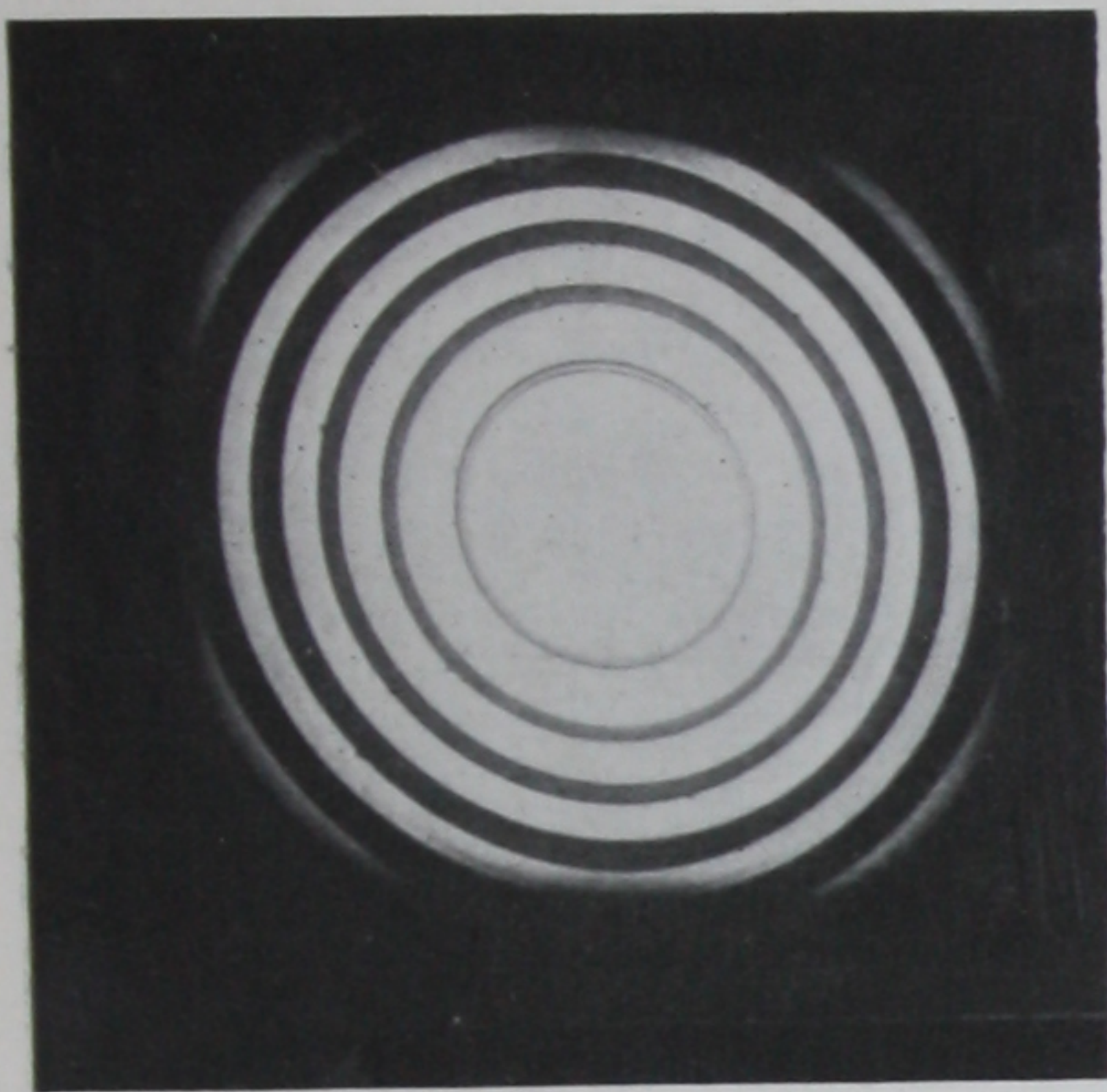


FIG. 13
The Optical System for MAZDA Motion Picture Lamp Projection

Make sure that all the elements in the optical system are accurately centered on the optical axis. Failure to do this will result in inefficient projection. The motion picture machine presumably has its aperture and objective lens correctly centered, leaving the condenser lens to be aligned with the aperture and the lamp filament with the condenser lens.

To center the condenser lens, find the focus of its rings on some flat surface a short distance in front of the objective lens. These rings should be concentric with the outline of the edges of the aperture plate, Fig. 14-A. However, in case the edges of the

aperture and the rings are indistinct, move the objective lens back and forth in its jacket until the desired image is obtained. If

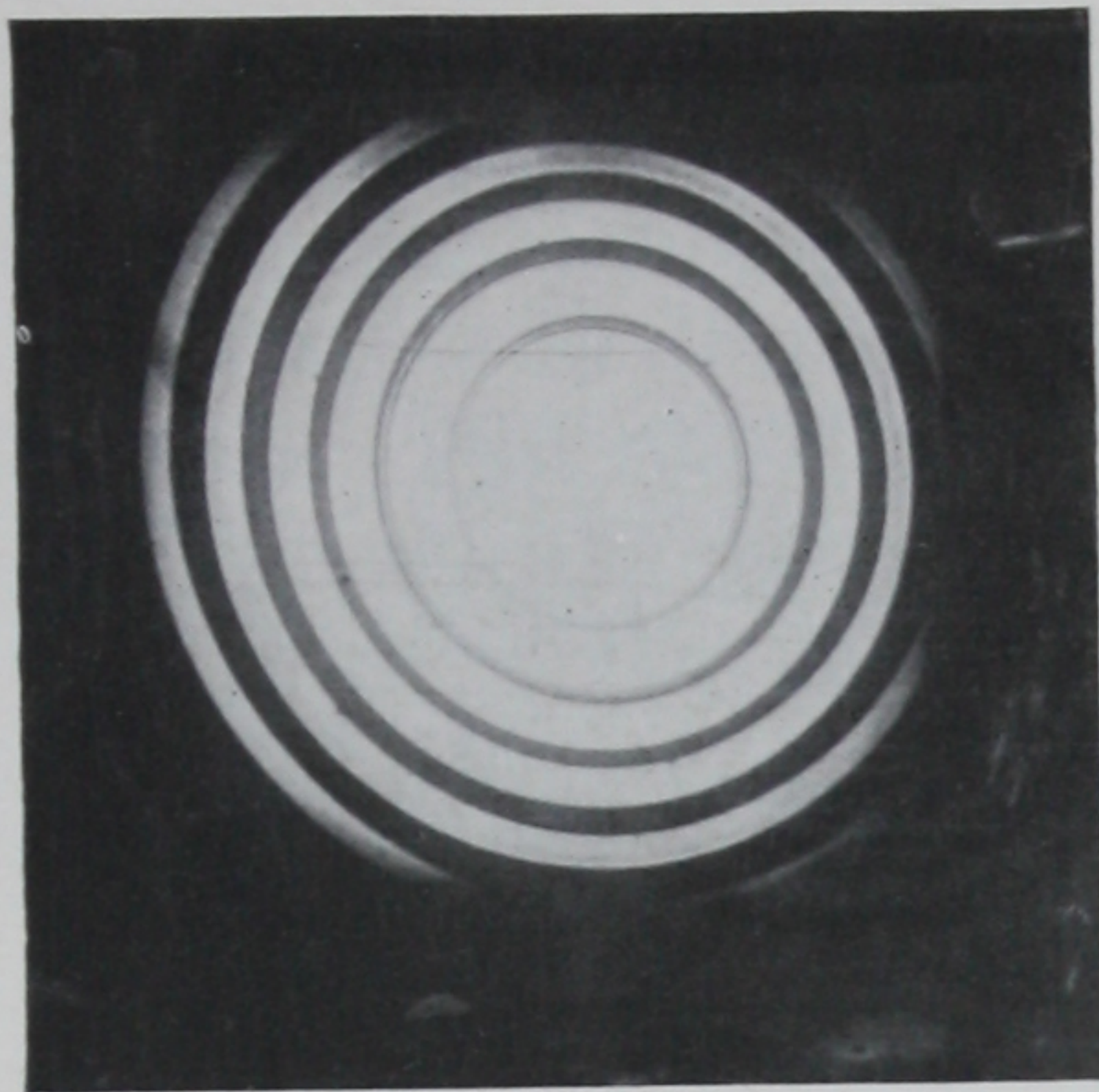


A

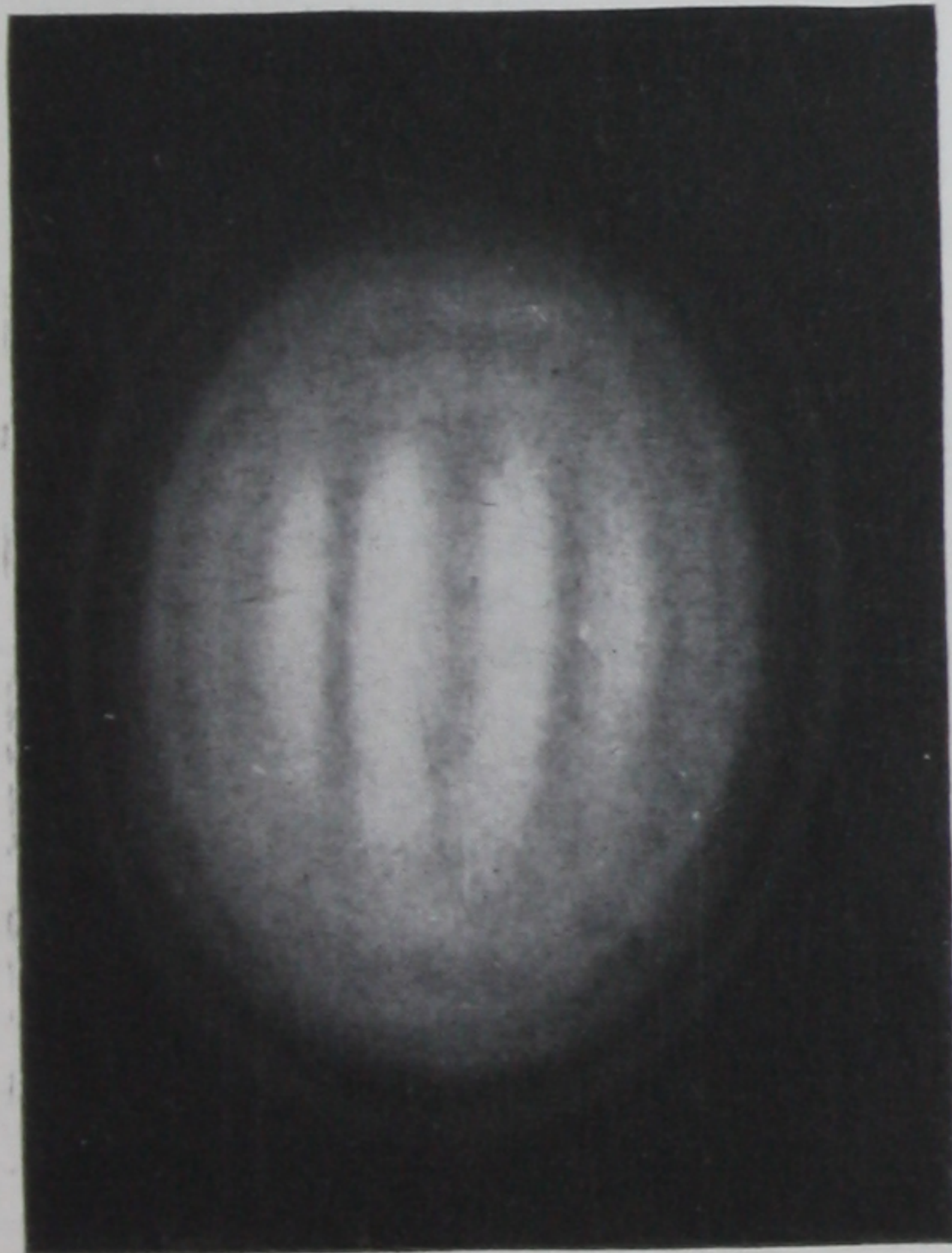
FIG. 14

B

Condenser Lens Properly and Improperly Centered



these rings are not so centered, Fig. 14-B, the condenser can be properly aligned by moving the housing laterally and vertically.

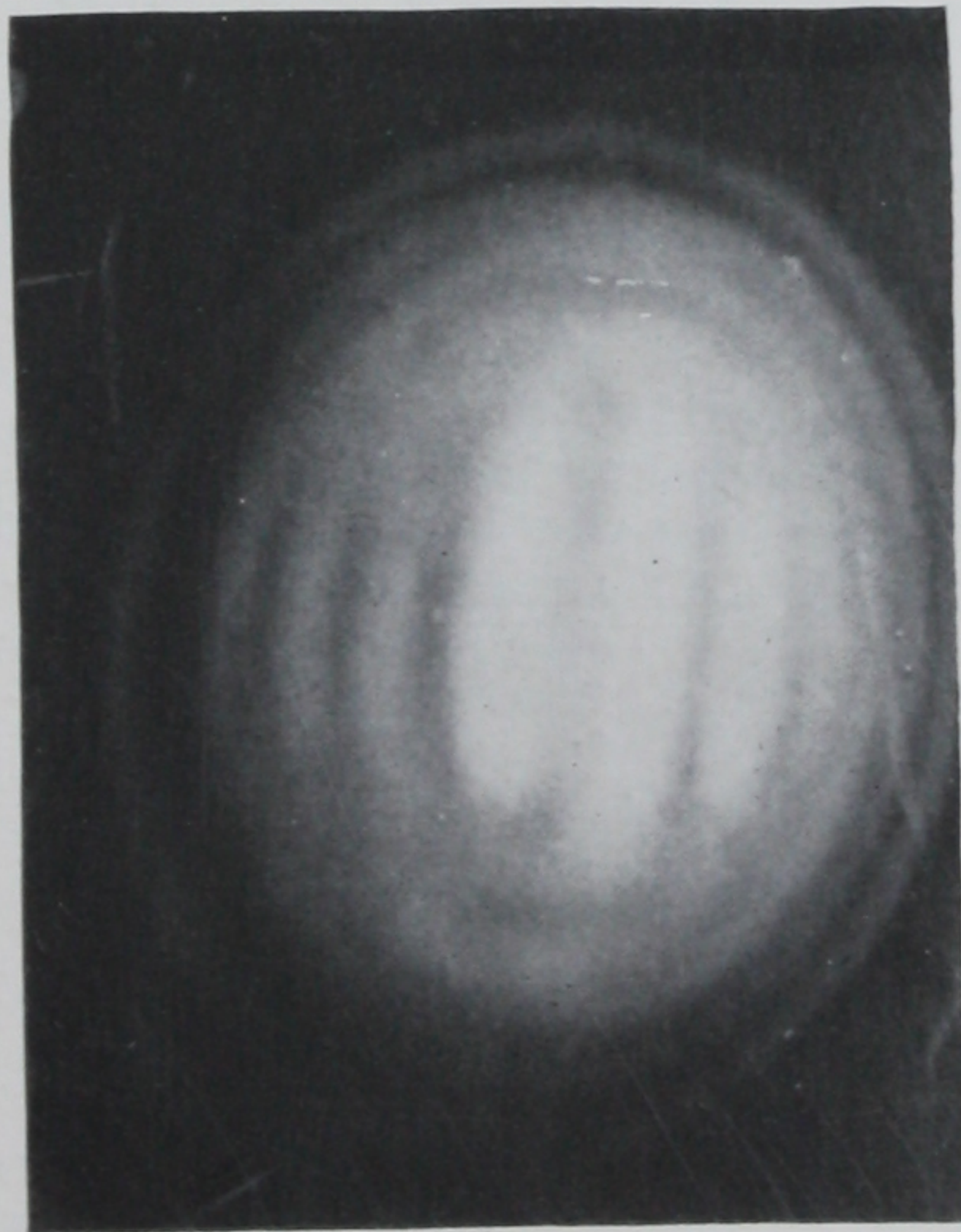


A

FIG. 15

B

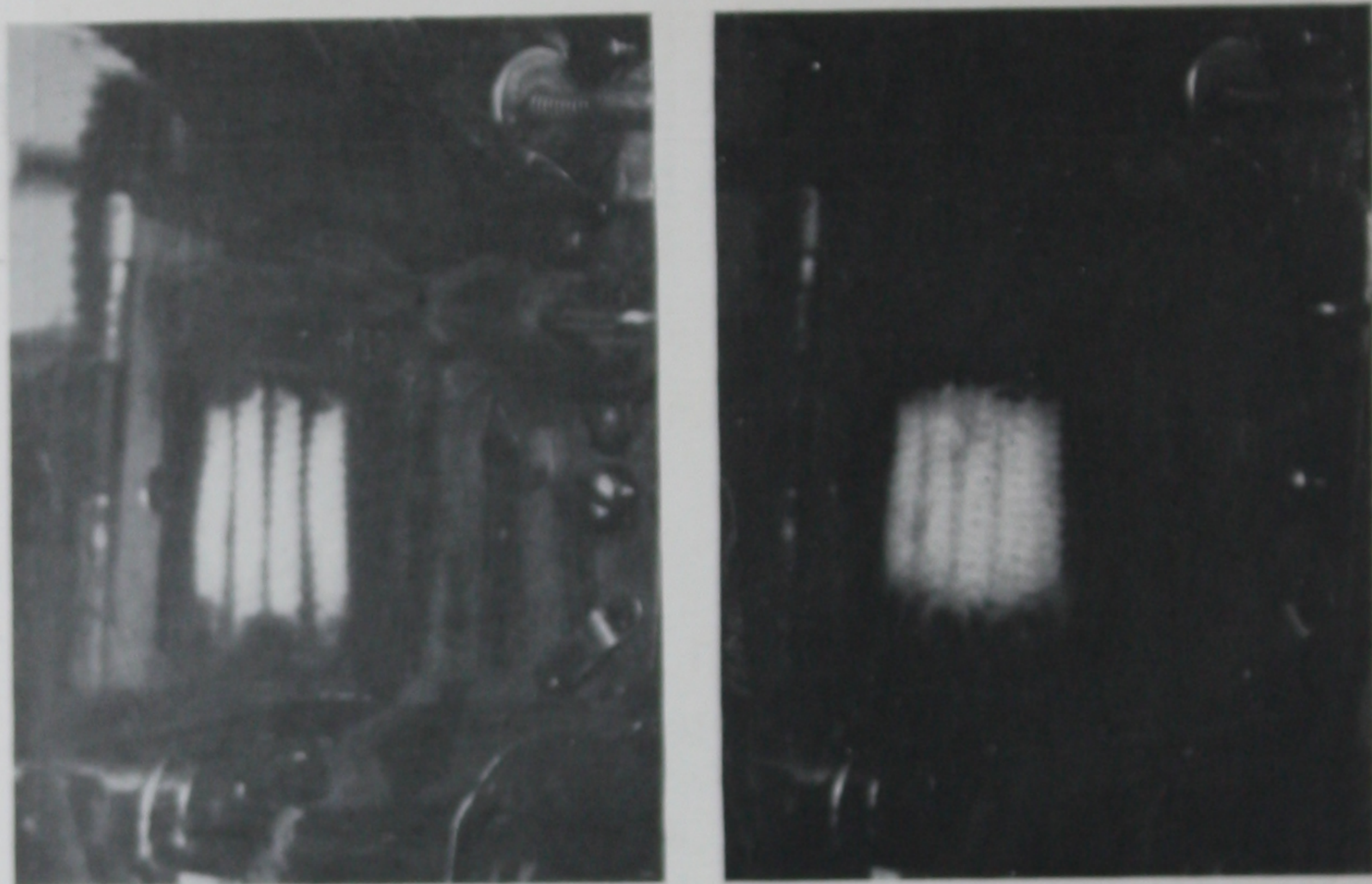
Filament Image Properly and Improperly Centered in Front of the Objective Lens



Always keep in mind that a slight error in alignment means a big loss of light on the screen.

The objective lens, aperture and condenser being centered on the optical axis, the setting of the lamp is the next element to consider. The first step is to turn the mirror to one side so that the reflected image will not interfere with the preliminary adjustment.

The lamp is placed at its correct height by the alignment of the exterior lamp setter. Therefore, it is only necessary to position the lamp and socket laterally. To do this, hold a dark, flat non-



A

FIG. 16

B

Method of Setting Image Thrown by Mirror with Reference to Filament. The view on the left shows the image produced of the filament alone; the one at the right shows the spaces between sections of filament filled by the reflected image giving a practically uniform light source. A pinhole in the center of the dowser causes the production of these images

reflecting surface (gray cardboard) in front of the objective lens. By moving this surface back and forth in front of the objective lens, the image of the lamp filament will be found.

Note whether the four coils of the filament are centered as shown in Fig. 15. If they are not, move the lamp and socket side-wise by means of the adjustment screw until the filament is correctly centered.

The only element remaining to be aligned is the spherical mirror. This is accomplished by the aid of the pinhole in the dowser. *Do not use this pinhole in the dowser for any other adjustment.* This pinhole will throw an inverted image of the filament on the fire

shutter, Fig. 16-A. By the mirror adjustments it is simple to align the reflected image so that it falls into its proper position, Fig. 16-B.

The image thrown by the mirror should fit into the actual filament in much the same manner that it is possible to fit the four fingers of the right hand into the four fingers of the left. The image should be the same size as the actual filament (Fig. 17).

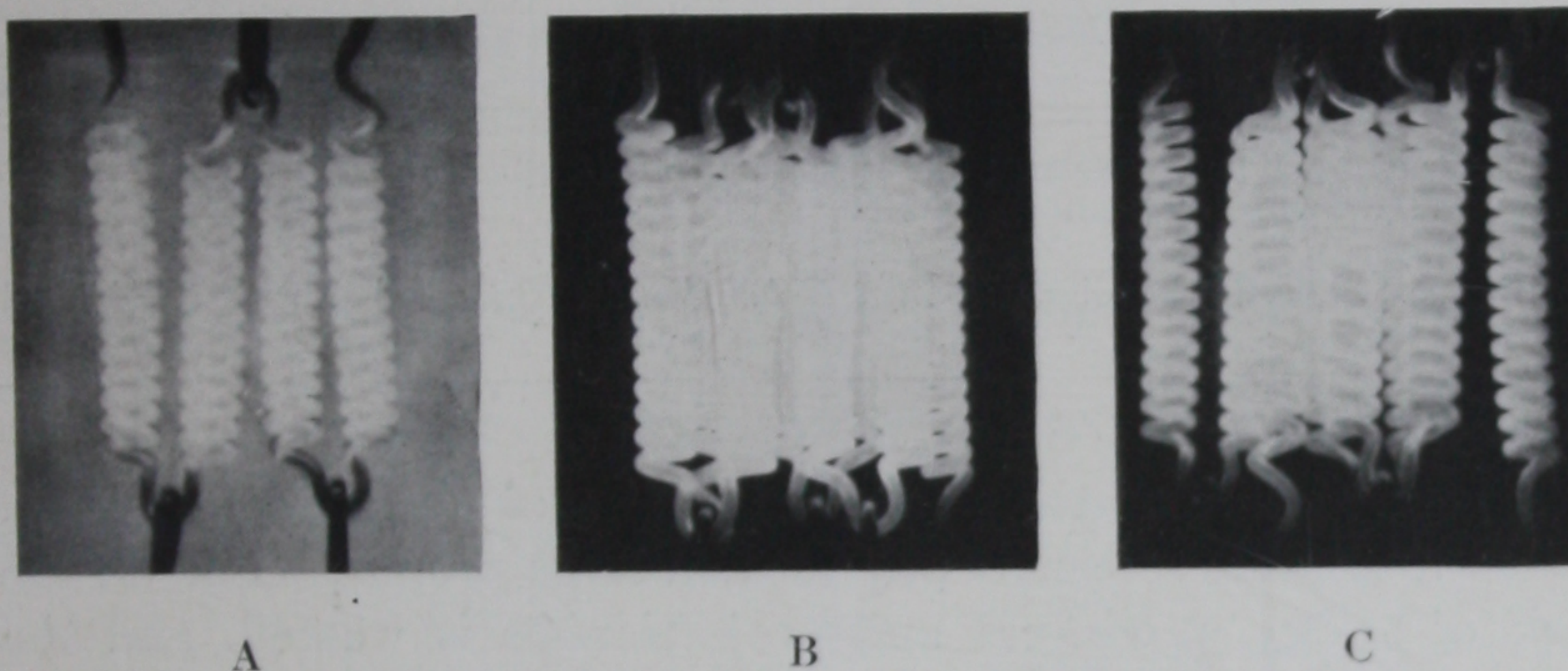


FIG. 17

The Filament of the MAZDA Motion Picture Lamp.—(A) Filament alone. (B) Filament and image correctly meshed. (C) Filament and image incorrectly meshed

Causes of Poor Screen Illumination and Their Remedies

A great many times when trouble arises with projection with the MAZDA lamps, it can be remedied by some simple correction in the equipment or method of using the lamp. Some of the most common causes for unsatisfactory results and the methods of correcting these causes are given below:

Low Intensity Screen Illumination

Causes

1. Lamps operated under amperage.
2. Optical system out of alignment.
3. Use of plano condenser lenses.
4. Lamp burned beyond its useful life as indicated by blackening of bulb or warping of filament.
5. Dirty mirror and lenses.
6. Use of number one or quarter size objective lens—1 $\frac{3}{4}$ in. dia.
7. Incorrect distances between parts of optical system.
8. Use of 3-wing shutter.

Remedies

1. Operate at rated amperage.
2. See "Method for Proper Alignment of Optical System."
3. Use prismatic lens.
4. New lamp.
5. Clean mirror and condenser with a soft brush every day. Optical system must be free from all foreign matter.
6. Use number two or half size lenses 2 $\frac{1}{2}$ in. dia. whenever possible.
7. See "Proper Alignment of Optical System."
8. Use 2-wing shutter.

*Low Average Life of Lamps**Causes*

1. Ammeter out of adjustment.
2. Improper method of lighting lamps.

Remedies

1. Correct by checking with standard meter.
2. Always use handle on regulator to avoid initial surge of current.

*Uneven Screen Illumination**Causes*

1. Use of plano condenser lenses.
2. Incorrect set of mirror.
3. Lamp filament badly warped out of parallel or small section short circuited.
4. Condenser lens out of alignment.

Remedies

1. Use prismatic lens.
2. Correct set. See "Proper Alignment of Optical System."
3. New lamp.
4. See "Proper Alignment of Optical System."

The Selection of Screens

A good picture on the screen is the aim of every projectionist. Unless a suitable screen is provided, a large proportion of all the work of artists, producers and projectionists is wasted, and the audience is dissatisfied.

By a suitable screen is meant one that will most efficiently fulfill all the requirements of a particular theater. While one type of screen will give excellent results in a particular house, the same screen might utterly fail to give similar results in another theater. This is the cause of many owners and managers being misled in the selection of screens. The screen chosen for a house should meet the following requirements in the most satisfactory manner:

1. Distribute the light so that the audience in every part of the house will see a clear, distinct picture.
2. Utilize the light that strikes it in the most efficient manner.
3. Possess a surface that is easy to keep clean.
4. Be of a character or material that will not depreciate rapidly, but maintain its original qualities.

The first two requirements are, from their very nature, conflicting and must be considered simultaneously. That is to say, for the audience to see a picture equally well illuminated from every part of the house, requires a screen that will reflect the light equally in all directions. It follows that a great deal of light will be reflected at angles not within limits of the area occupied by the audience, thus decreasing the efficient utilization of the total light thrown on the screen.

Perhaps the most efficient method of using all the light reaching the screen would be through a roughened or etched mirror.

However, in this extreme case, only a very small portion of the audience would see the picture. It follows that a balance should be sought between these requirements, selecting some screen that

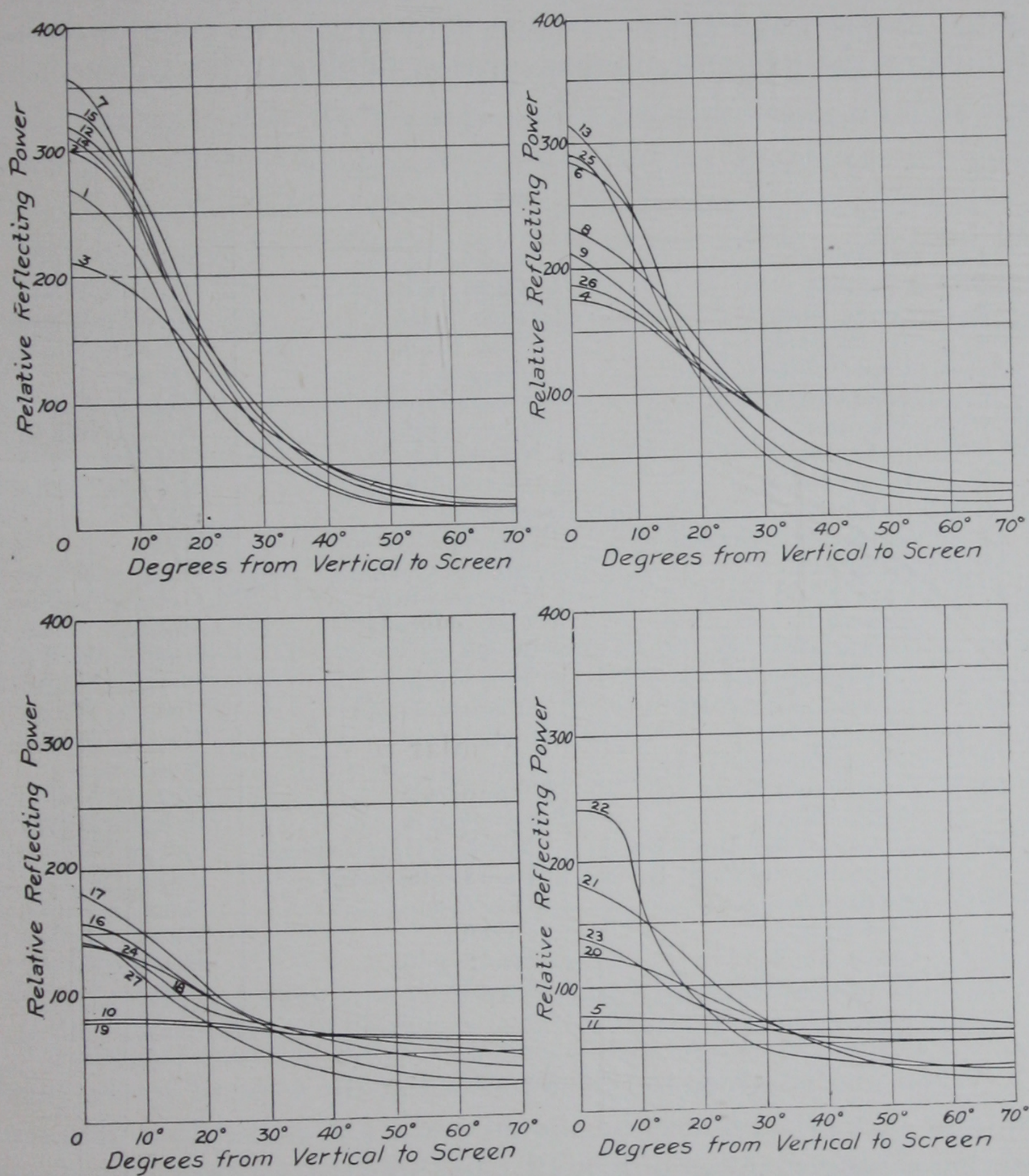


FIG. 18

Reflection Characteristics of Various Commercial Motion Picture Screens

will give both a good picture to all the audience and at the same time reflecting as much light as possible under the given conditions.

With these considerations in mind, we find each theater offers a problem in the selection of a screen best suited for its requirements. However, no difficulty should be encountered in solving this problem,

providing use is made of the technical data now available on the majority of commercial screens.

The curves in Fig. 18 show the reflection characteristics of the various projection screens, which are listed below as to trade-name, texture and color. In the column on the extreme left, is tabulated the reference numbers corresponding to the curves.*

No.	Name	Texture	Color
1	Superlite	Coarse Grain	Metallic White
2	Special	Coarse Grain	Metallic White
3	Green Back	Fine Grain	Metallic White
4	White Back	Fine Grain	Metallic White
5	Plain White Coated	Smooth	Yellow
6	Imsco Silver No. 1	Coarse Grain	Metallic White
7	Minusa B	Coarse Grain	Metallic White
8	Imsco No. 2	Coarse Grain	Metallic White
9	Imsco No. 3	Coarse Grain	Metallic White
10	Half-tone	Smooth	White
11	Imsco White Muslin	Smooth	White
12	Minusa A	Medium Grain	Metallic White
13	Imsco Gold No. 1	Coarse Grain	Metallic Yellow
14	Minusa C	Coarse Grain	Metallic White
15	Mazda-lite	Fine Grain	Metallic White
16	Idealite—Grade A1	Fine Grain	Metallic White
17	Idealite—Grade 1B	Medium Grain	Metallic White
18	Idealite—Grade 2	Fine Grain	Metallic White
19	Dalite Crystal White	Smooth	Blue Green
20	Dalite Gold Fiber	Fine Grain	Metallic Yellow
21	Dalite Silver	Fine Grain	Metallic White
22	Argus Crystal Bead No. 1	Medium Glass Beads	Yellow
23	Argus Crystal Bead No. 2	Fine Glass Beads	Yellow
24	Mirroroid	Fine Grain	Metallic White
25	Gold Ring	Smooth	Metallic Yellow
26	Imsco No. 4	Fine Grain	Metallic White
27	Aluminium Paper	Smooth	Metallic White

When one is interested in determining the type of screen most suitable to a given house, he should make use of the floor plan and seating arrangement as in Fig. 19. In this case, we have considered the advisability of using a reflecting type screen with the characteristics as shown in Curve 7, Fig. 18. This has the most pronounced specular (mirror) reflection properties of any shown.

With the screen as a center, radial lines are drawn at 10-deg. intervals. Using a convenient scale, a series of concentric circles are next superimposed. The values from the curve at the various angles are plotted on the chart just prepared.

* Paper on "Reflection Characteristics of Projection Screens," by L. A. Jones and M. F. Fillius, *Transactions, Society of Motion Picture Engineers*, Vol. XI.

In contrast with this type of screen, we have chosen another that distributes the light uniformly at all angles. This is known as the diffusing type screen, and Curve 10, Fig. 18, shows its properties.

With the distribution curves of both of these screens marked on the floor plan, we are in a position to study both types simultaneously and choose one best suited to meet local conditions.

Referring to Fig. 19, it will be seen that, down the center of the house, the reflected light is very great and for 30 degrees on both sides of the center the reflected light, although falling off rapidly, is still high. Beyond 30 degrees, the values are low, and consequently it is evident that this type of screen is best suited to long, narrow houses, where the great majority of seats are placed within

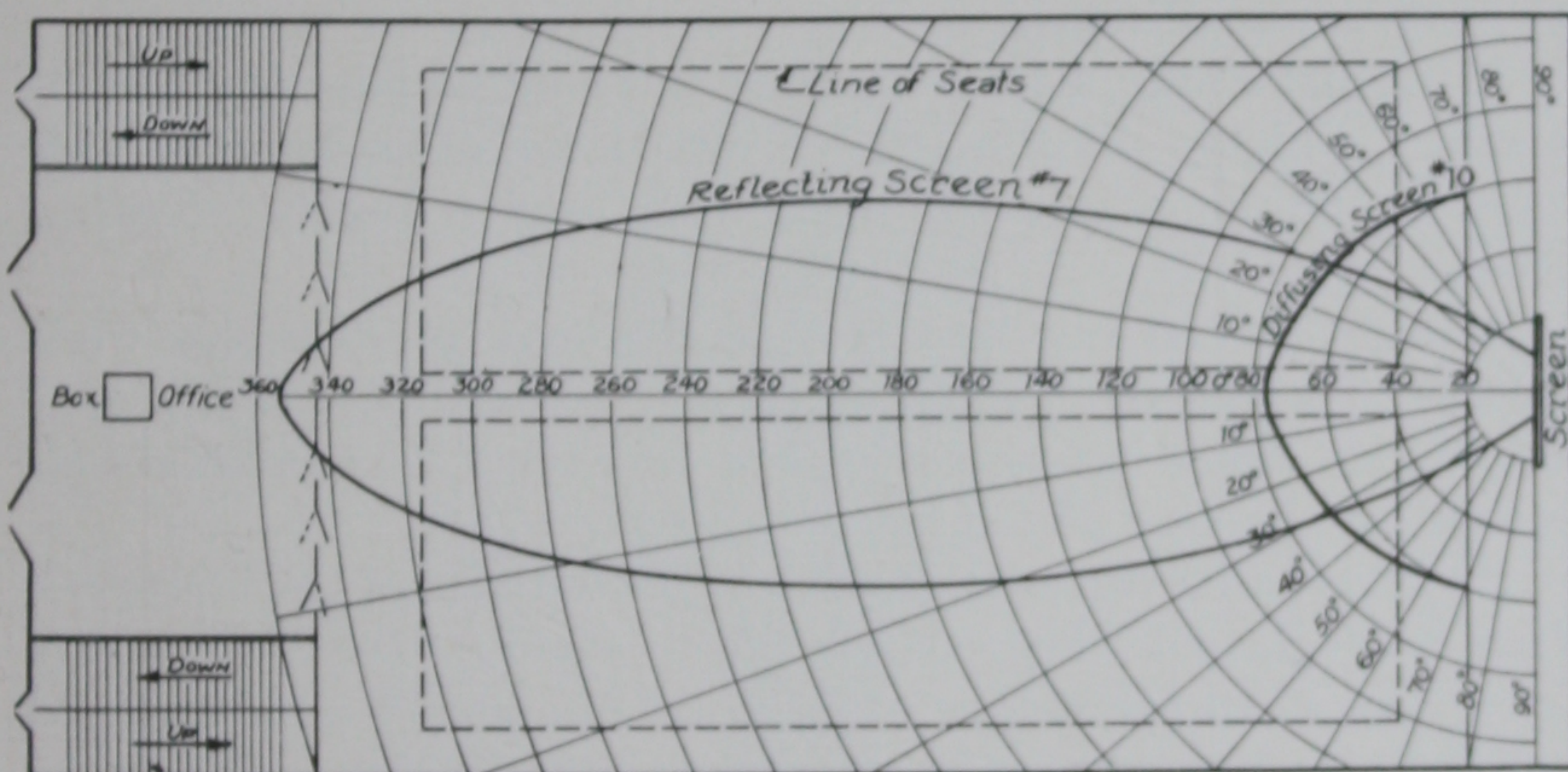


FIG. 19

Floor Plan of Typical Theater with Curves Showing Relative Reflecting Characteristic of Two Extreme Types of Screens, as It Appears to an Audience in the Theater.

A desirable method of determining the suitability of a given screen to a particular house

this angle of 60 degrees (30 degrees on each side of the center line). In the case shown, the seats between 30 degrees and 65 degrees, which form a fairly small percentage of the total number of seats, would have a low apparent screen brightness (screen would appear relatively dark).

When considering screen No. 10, however, it will be seen that the light is almost uniformly distributed at all angles between 0-70 degrees. In other words, the screen would be of equal brightness regardless of the angle of observation, and hence the seats between 30-65 degrees, which, under the reflection screen, first considered

were dark, compared with the center seats, would now be about as good as those between 0-30 degrees.

The argument is likely to rise that if this is so, then why not use a diffusing screen for all sizes of houses, and thus have every seat practically as good as another? It must be remembered that this *evenness* of reflected light is being secured at the cost of the *strength* or *intensity* of reflected light over the largest area of the house. Hence, for maximum utilization, a reflecting type screen should always be used where conditions justify it.

Neither of these screens would satisfactorily fulfill the requirements of this theater and it would be necessary to select a screen that partook of the characteristics of both the screens. A screen of the characteristics shown in Curve 8, Fig. 18, would be better suited to our conditions.

If we had a long, narrow theater, it would be poor engineering to select a highly diffusing screen, or on the other hand, a wide house would be poorly equipped if it used a highly reflecting screen.

A fairly general rule that may be followed to advantage when selecting a screen is: "*The maximum light received by any part of the audience should not be greater than three times the minimum light received by any other part of the audience.*"

However, a few seats on the extreme front side of the house can often be neglected when considering a screen. These constitute but a very small percentage of the total number of seats, but add materially to the extreme angle of the lines of vision. Distortion of the figures projected on the screen, which result when the angle of view is large (about 70 degrees), cannot be remedied by any screen.

Small Motion Picture Machines, Their Field and Operation

The small portable motion picture machine is fast coming into very common use through its advantages in education, advertising and home use. The non-professional operators of these machines are generally not familiar with the fundamentals of projection and fail, in a great many cases, to secure efficient utilization of the light source. A few suggestions outlined below may be found helpful in overcoming some of the common causes of unsatisfactory screen illumination.

Usually the MAZDA lamp is inserted in the lamp housing, lighted and the machine started. However, this procedure does

not insure good projection as it is quite probable that the light source and mirror are not properly placed. It is a simple matter to align these two elements, and by so doing, quite often the screen illumination will be nearly doubled.

If the machine is equipped with a mirror in the lamp housing, block off the light from the mirror with a piece of non-reflecting material, so that it will reflect no light into the lens system. With the lamp lighted, move a piece of cardboard back and forth in front of the objective lens, until an image of the lamp filament is obtained (Fig. 15). The lamp itself should then be moved both laterally and vertically, if necessary, until this image appears to be centered in front of the objective lens. The lamp is fastened in this position.

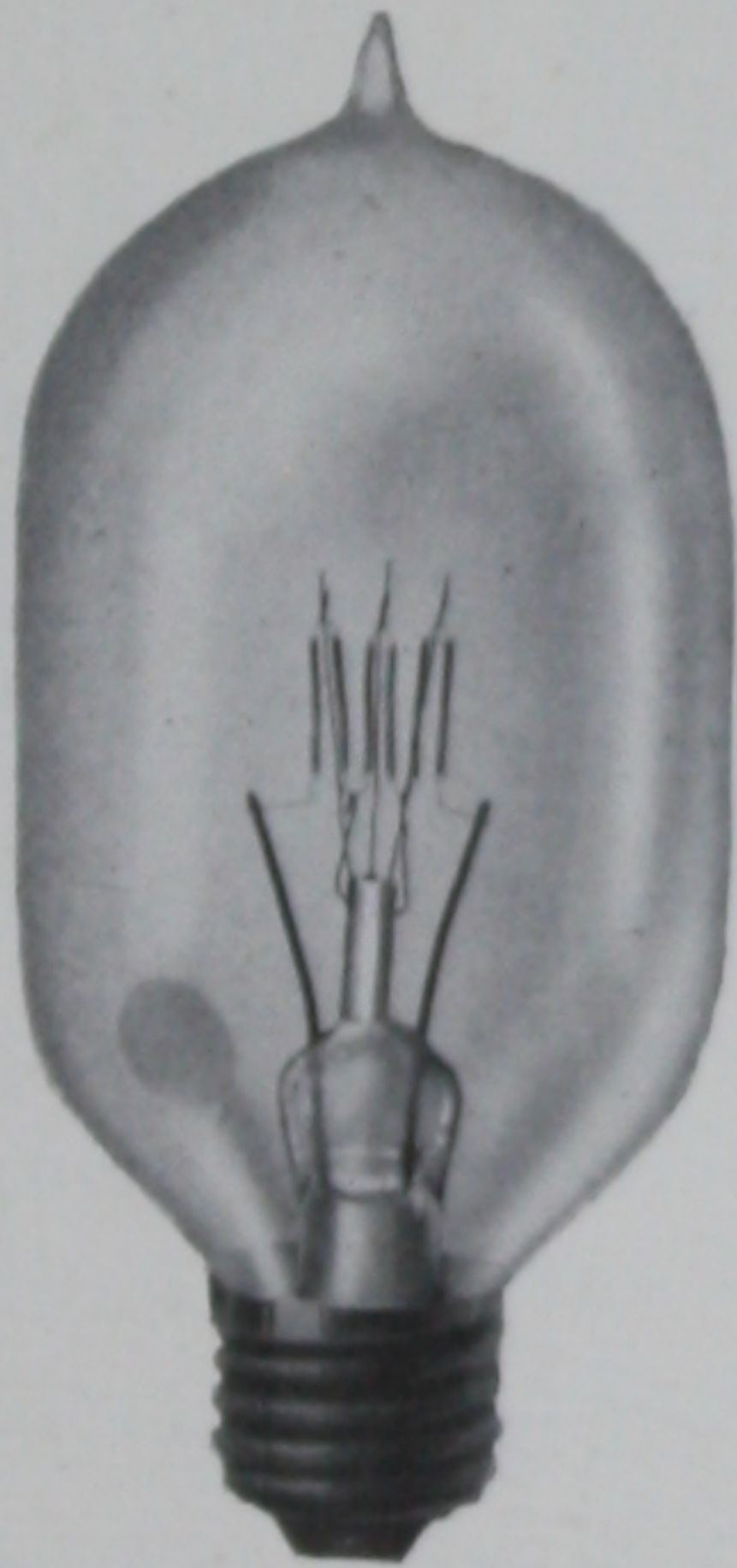


FIG. 20

A Typical Lamp for Small Portable Motion Picture Machines—the 400-watt MAZDA C Projection Lamp Which is Made for 110, 115 and 120 Volts in the T-20 Bulb

Whatever was used to block off the mirror is now removed and the mirror adjusted to obtain the best results. Again, placing the cardboard in front of the objective lens, in the same manner as employed for the lamp, the image thrown by the mirror should be found at the same place as the image of the actual filament. If this is not the case, move the mirror back and forth until the two images come at the same place and are the same size. The image thrown by the mirror should fit in between the actual filament image, Fig. 17.

Unfortunately, there is no one standard voltage for all lighting circuits, that is, the line voltage may be any value from 100 to 125.

While there is no danger of damaging the lamp (assuming a 110-volt lamp) if burned on 100 volts, the light will be very materially reduced. However, if 125 volts is applied to this lamp, the life will be shortened very greatly, although, of course, there will be some compensation through the increase in screen illumination.

To prevent this excessive voltage being applied to the lamps, it is recommended that a variable resistance be employed in the lamp circuit. Then, when the line voltage is in excess, it is a simple matter to reduce it, permitting the lamp to burn at the proper rating.

The Motion Picture, an Important Factor of Our Educational System

Most of us think of the motion picture as an entertainment element of our daily life and seldom realize its latent possibilities as a means of education. Any one who has thought on the matter seriously, however, is astounded at what the future holds for this industry. The man with a prophetic vision sees the day when each classroom will have its projector, when the elementary studies, such as geography, history and even drawing will be taught through this medium.

The high speed camera has opened up a new field in the study of motion and such activities as dancing, piano playing, athletic sports, tool operation, military drill, handling of material, biology, plant growth and a hundred and one similar subjects will be at our disposal.

The day is not far distant when we will see established libraries of motion picture films as comprehensive and widely used as our present day store-houses of printed books.

Educators realize that the motion picture is a highly interesting and most efficient method of training young and old and we are just at the dawn of a new era in education.

The simplified, inexpensive camera for taking motion pictures has now appeared and ere long the amateur will have his set of films to show to his friend as he now thumbs the pages of his snapshot album. Think how interesting the evening at home will become when the intimate, personal element of the family activities can be portrayed on the living room wall. It is reasonable to assume that the small motion picture projector will be as popular a form of entertainment as the phonograph is today.

The MAZDA lamp for motion picture projection is probably the one element which will make all this wonderful advance in the art possible. Its inherent features of simplicity of operation, compactness, safety and low power consumption make this possible. The motion picture projector for the home or school room can be plugged in the existing lighting circuit due to its low power demands without danger of blowing the fuse. No experience is necessary to operate the lamp and focus the device.



The Foot-Candle Meter

The Foot-Candle Meter is a very simple and compact portable photometer, selling at the low price of \$25.00. The Foot-Candle Meter proves very useful in connection with motion picture projection in checking the intensity of light on the screen. It can be placed at different points and the average intensity calculated from the individual readings. The usual method of operation is to divide the screen into 12 or 16 equal areas and read the foot-candle intensity at the center of each area. Thus, if we know that a certain installation gives a first-class projected picture, it may be of interest to know just how much light is actually on the screen so that if changes are made in the apparatus the projectionist can measure the actual increase or decrease in the intensity of light.

The Foot-Candle Meter is as simple to use as a thermometer, a water or steam gauge. The scale is direct reading, and the only adjustment necessary is that of the rheostat to bring the standard lamp to the correct voltage.

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TABLE 2
PROJECTION TABLE

Showing Size of Screen Images at Different Distances with Lenses of Different Focal Length

Equiv. Focus Inches	DISTANCE FROM LENS TO SCREEN											
	40 Ft.	50 Ft.	60 Ft.	70 Ft.	80 Ft.	90 Ft.	100 Ft.	110 Ft.	120 Ft.	130 Ft.	140 Ft.	150 Ft.
4.00	9.1 6.8	11.3 8.5	13.6 10.2	15.9 11.9	18.1 13.6	20.4 15.3						
4.25	8.5 6.3	10.7 8.0	12.8 9.6	14.9 11.2	17.0 12.8	19.2 14.4	21.3 16.0					
4.50	8.0 6.0	10.1 7.6	12.1 9.1	14.1 10.6	16.1 12.1	18.1 13.6	20.1 15.1	22.22 16.6				
4.75	7.6 5.7	9.5 7.2	11.4 8.6	13.3 10.0	15.3 11.5	17.2 12.9	19.1 14.3	21.0 15.7	22.9 17.2			
5.00	7.2 5.4	9.1 6.8	10.9 8.2	12.7 9.5	14.5 10.9	16.3 12.2	18.1 13.6	19.9 15.0	21.8 16.3	23.6 17.7		
5.25	6.9 5.1	8.6 6.5	10.4 7.8	12.1 9.1	13.8 10.4	15.5 11.7	17.3 13.0	19.0 14.3	20.7 15.5	22.4 16.8	24.2 18.1	
5.50	6.6 4.9	8.2 6.2	9.9 7.4	11.5 8.7	13.2 9.9	14.8 11.1	16.5 12.4	18.1 13.6	19.8 14.8	21.4 16.1	23.1 17.3	24.7 18.5
5.75	6.3 4.7	7.9 5.9	9.5 7.1	11.0 8.3	12.6 9.5	14.2 10.6	15.8 11.8	17.3 13.0	18.9 14.2	20.5 15.4	22.1 16.6	23.6 17.7
6.00	6.0 4.5	7.5 5.7	9.1 6.8	10.6 7.9	12.1 9.1	13.6 10.2	15.1 11.3	16.6 12.5	18.1 13.6	19.6 14.7	21.1 15.9	22.6 17.0
6.25	5.8 4.3	7.2 5.4	8.7 6.5	10.1 7.6	11.6 8.7	13.0 9.8	14.5 10.9	16.0 12.0	17.4 13.0	18.8 14.1	20.3 15.2	21.8 16.3
6.50		7.0 5.2	8.4 6.3	9.8 7.3	11.1 8.4	12.5 9.4	13.9 10.5	15.3 11.5	16.7 12.5	18.1 13.6	19.5 14.6	20.9 15.7
6.75		6.7 5.0	8.1 6.0	9.4 7.1	10.7 8.1	12.1 9.1	13.4 10.1	14.8 11.1	16.1 12.1	17.4 13.1	18.8 14.1	20.1 15.1
7.00		6.5 4.9	7.8 5.8	9.1 6.8	10.3 7.8	11.6 8.7	12.9 9.7	14.2 10.7	15.5 11.7	16.8 12.6	18.1 13.6	19.4 14.6
7.50		6.0 4.5	7.2 5.4	8.5 6.3	9.7 7.3	10.9 8.2	12.1 9.1	13.3 10.0	14.5 10.9	15.7 11.8	16.9 12.7	18.1 13.6
8.00			6.8 5.1	7.9 5.9	9.1 6.8	10.2 7.7	11.3 8.5	12.5 9.4	13.6 10.2	14.7 11.0	15.9 11.9	17.0 12.7
8.50			6.4 4.8	7.5 5.6	8.5 6.4	9.6 7.2	10.7 8.0	11.7 8.8	12.8 9.6	13.9 10.4	14.9 11.2	16.0 12.0
9.00			6.0 4.6	7.0 5.3	8.1 6.0	9.1 6.8	10.1 7.6	11.1 8.3	12.1 9.1	13.1 9.8	14.1 10.6	15.1 11.3

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